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New York State Museum, Albany

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NEW YORK STATE EDUCATION DEPARTMENT
1908

STATE OF NEW YORK

No. 68

IN ASSEMBLY

JUNE 26, 1907

60th ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

To the Legislature of the State of New York

We have the honor to submit herewith, pursuant to law, as the 60th Annual Report of the New York State Museum, the report of the Director, including the reports of the State Geologist and State Paleontologist, and the reports of the State Entomologist and the State Botanist, with appendixes.

ST CLAIR MCKELWAY
Vice Chancellor of the University

ANDREW S. DRAPER
Commissioner of Education

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New York State Education Department

New York State Museum

John M. Clarke, Director

Memoir 9

EARLY DEVONIC HISTORY

OF

NEW YORK AND EASTERN NORTH AMERICA

BY

JOHN M. CLARKE

ALBANY

NEW YORK STATE EDUCATION DEPARTMENT

1908

STATE OF NEW YORK

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New York State Education Department
Science Division, December 20, 1905

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I communicate herewith for publication a memoir entitled "Early Devonic History of New York and Eastern North America."

Very respectfully
JOHN M. CLARKE
State Geologist

Approved for publication December 20, 1905

A. S. Draper

Commissioner of Education

PERCÉ ROCK

New York State Education Department

New York State Museum

John M. Clarke, Director

Memoir 9

EARLY DEVONIC HISTORY

OF

NEW YORK AND EASTERN NORTH AMERICA

BY

JOHN M. CLARKE

PART I

INTRODUCTION

In geologic as in other science no state liveth unto itself. Political boundaries are not the metes of knowledge. The geology of New York is not an esoteric cult; the succession of its rock formations and the composition of the ancient faunas buried therein are so excellently known that the New York Series of Geologic Formations has long stood and still remains a standard for exact comparison wherever problems relating to the older rocks of the earth present themselves. For seventy years the factors in the geologic history of this State have been zealously acquired with undiminishing ardor. Today their body is vast in detail and the foundation of broad conclusions of far-reaching significance. The geologic history of New York in all that the term implies — its geographic development, the uplifting and modification of its surface, the procession of life forms of its ancient seas — is approaching an accurate expression. The State, however, does not and never can in itself afford the solution of its own problems. The New York series of formations spreads away from its typical region to all points of the compass, and in all these directions, howsoever far it extends, light is to be sought for the explication of past geologic conditions

in New York. My predecessor, Prof. James Hall, at various times during his long official career of sixty-three years, sought, found and portrayed in his reports the faunas of these formations in their extent to the west and south. He established his purpose to demonstrate that the New York series as erected by the original survey of the State, 1836–43, extended beyond the limits of the State. The work of others, official geologists of individual states and independent private investigators, has confirmed and supplemented this work through those regions. Eastward and to the north, over country where the rocks are largely crystalline and in vast areas of unchanged sediments, much less has been acquired. Here again we recognize the labors of geologists, but for the most part the region is so extensive and the efforts made so desultory and discontinuous that in effect much of it remains a virgin field to the student of its past.

The problems of today in this study of New York are not wholly those of a generation ago. We are seeking light on the broader questions of changes in continental coast lines, in the upbuilding of the country, of the tidal flow of the ancient seas, their currents and depth, on the origin and the direction of migration of their faunas and the evolutionary changes of their constituent organisms. In the prosecution of these themes we can safely proceed only by the method of closely analyzing the character and affiliations of the fossil remains. Such knowledge is of fundamental importance. Without it in its fulness conclusions can be but hasty and tentative, resulting in assumptions and hypotheses. To acquire it costs vast labor, to interpret it caution and keen appreciation. To neglect it, to pluck here and there a salient character and with these plunge into the depths of inference, or to approach it with too narrow an equipment, is to rear a structure which will stand but for a day.

We do well to follow in this procedure the standards which our fathers have set up and which the common experience in the science concedes to be imperative. It is too soon to lay down the hammer and construct in the study a philosophy of the earth. Vast as has been the acquisition of geologic facts, "hammers and chisels and a' " must still be the watchword of future generations of students in this science.

THE EARLY DEVONIC OF NEW YORK

The theme of this treatise bears upon one period only of our geologic history. It is not to fight again the battles as to where the division line between the great Siluric and Devonic systems is to be drawn or as to what constitute the early stages of the Devonic record. Such contentions are effectively determined; only an occasional shot is heard from some dreamer who slept while the battle was on and wakes to find the field taken and the issue determined.

We here endeavor to portray and to bring into comparison with the early Devonic of New York, faunas of like age from regions of eastern Quebec, northern New Brunswick, northern and eastern Maine; incidentally other regions of smaller area and already closely studied — St Helen's island at Montreal, Lake Memphremagog on the boundary of Vermont and Quebec, northern New Hampshire and western Massachusetts — have been brought within the scope of the work, so closely are all these regions knit to New York and so important have been their contributions to its history.

In New York the deposits constituting the earliest members of the Devonic series are, at the bottom, 1) the Helderbergian and, overlying, 2) the Oriskanian. There is a demonstrated gradation of the sediments and the faunas of the lower into the higher, and those at the summit of the Helderberg series — Port Ewen beds — carry so large a representation of Oriskany species, as shown by recent analyses, that they may be wisely regarded as indicating the passage of the earlier into the later fauna.

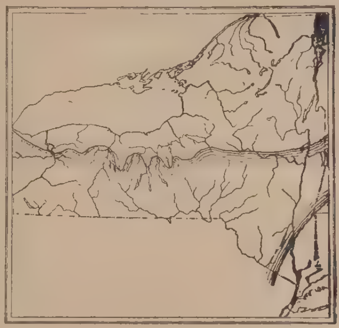
The Helderbergian rocks (in the Helderberg mountain region comprising the following divisions from below upward: 1 Coeymans limestone, 2 New Scotland limestone and shale, 3 Becraft limestone) enter New York from the southeast along the New York-New Jersey line, and end northward in an abrupt escarpment facing east and north in the southern angle of the present Hudson and Mohawk rivers. Of this heavy sheet of calcareous strata there is no trace in New York east of the Hudson river save two small synclinal outliers in Columbia county, Becraft mountain and Mt

Bob. As the formation progresses northward from its entry into the State its thickness increases to where it is abruptly cut off in an erect wall. The Helderberg escarpment carries in its very topography the evidence of a former wide extension on toward the east and northeast. The continuation of this formation westward in New York is notable for its rapid thinning and quick disappearance. The subdivision at the Helderberg mountain is soon lost westward. The lower division or Coeymans limestone appears to be that extending farthest, as far as the eastern limits of Onondaga county, but the narrow east and west extent of the Helderberg sea is shown by the entire absence of the higher divisions far west of Schoharie creek.

The Oriskany period succeeding, was a time of transgression over the Helderberg deposits beneath. Then the northern coast line in western New York was broken and embayed. While calcareous deposits were formed in the deeper water of the southern reaches, the shore deposits of sand extended westward to Buffalo, in part over eroded surfaces of Siluric limestones to which the Helderbergian sediments had not extended. We have had occasion to show that from the Helderberg westward the sandy shoal water deposits of this Oriskany time are lenses and thin sheets often disconnected, in some places rising to considerable thicknesses of friable quartz shore sand into which the waters have rolled the organic remains of the outer sea. These lenses we conceive were separated by tongues of land dividing the embayments of the shore line. The Oriskany in our view presents in New York a twofold facies, that of the deeper littoral represented by the calcareous deposits from the Helderberg southward to Port Jervis and that of the shallow littoral from Schoharie westward; yet it is quite probable that the latter deposits are of later date than most of the former and represent the final transgression of shore sands over the sinking land of Helderbergian time.


The Helderberg sea in New York

The geographic conditions then in New York at this early date may be briefly outlined as follows: The great interior Mississippian sea which stretched a broad arm eastward into the Appalachian region during both earlier and later times, forming the Appalachian gulf, was, in the Helderbergian period, excluded from the present western, southern and central regions of New York, for it was a time of elevation of the continent and most if not all those portions of this State were then land, but land to be again depressed and overridden for ages by the seas. This ancient continental land extended far to the south along the present Appalachian region and east of it lay a sea way which we know to have been bounded without or on the eastern side by a land barrier, probably of continental dimensions. It has been argued with reasonable security that from the southern Appalachians of Maryland and Tennessee northward this sea way was a relatively narrow channel, widening out at places into basins favorable for the propagation of extensive faunas and forming an open connection with the ocean waters at the south and a free passage for migrant organisms. We must thus predicate for New York at the opening of the Devonic time a land area which was practically the entire State save its eastern and southeastern portions where the tides flowed through the marine waters of the Helderberg channel, hemmed in on the east by a land mass of whose extent toward the present Atlantic we have still much to learn. There is now before us the problem as to the opening of this channel beyond the present site of the Helderberg mountains eastward, and its course till it reached the open waters of the ocean at the northeast. We can not in this place give expression to our interpretation of this problem or full credit to the efforts others have made toward its solution till we have marshaled the evidence of the faunas it is here proposed to discuss. We may again remark, however, that after Helderberg deposits had long continued in New York, the basin or chan-



The Oriskany sea in New York, showing the western transgression

nel widened and the sea transgressed its western boundaries, carrying with its sediments the later modified faunas over what had been the land. This was the period of Oriskany sediment. Notwithstanding the opening out of this New York basin in its later history so closely are the faunas of the Helderberg and Oriskany knit together that much of our evidence will be found to bear as forcibly upon the latter as the former in all queries as to the origin of the faunas and their distribution.

Attention must also be directed to the fact that the Oriskany fauna, after enduring for a time in this broadened basin till it had purged itself of its Helderbergian elements, adds to itself forecasting elements of that fauna which distinguishes the next succeeding geologic stage (Onondaga). This phenomenon is not evident in New York but has been lucidly shown to be the condition in the strata of western Ontario, in what have been termed the Decewville beds. It is essential that we keep before us in the interpretation of the eastern faunas this important fact that late stages of the Oriskany fauna become commingled with the incoming migrants of the next organic invasion.

With these prolegomena we may let the summation of our theses wait upon the adduction of the evidence.

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I have many acknowledgments to make for personal coöperation and assistance in this work, often from sources least expected. These acknowledgments are chiefly made in the course of the book but in some instances we may follow the custom of the Greeks and not sacrifice to our heroes till after sunset.

SKETCH OF THE GEOLOGY OF GASPÉ

Gaspé (to give location to our observations) is the vast peninsula of eastern Quebec which lies between the broad mouth of the St Lawrence river and the Bay of Chaleurs, facing the waters of the Gulf of St Lawrence. It is the Gaspé Peninsula, more trippingly termed in the French, Gaspésie, and in the English, Gaspesia, charmingly corrupted by the *habitant* to Gaspesy. Speaking with precision, and as we shall hereafter employ the term, Gaspé is Gaspé county, which with Bonaventure county at the south divides the great peninsula. It is Gaspé county which here concerns us most, which carries the most striking contrasts of coast and mountain, which is farthest from the world's thoroughfares and where the geologic features are most inviting.

Gaspé county in size might be a king's realm. It is as large as the kingdom of Saxony or the state of Massachusetts, but its interior is almost as much a wilderness as it was when the geologist Logan first began his traverses of the region. The people of the country are scattered along the shores in settlements given over to the cod fishing as they have been during all the civilized history of the region, which extends back over a period of nearly three centuries. Likewise the most interesting problems presented by the rocks are marshaled along the coast which the relentless and inevitable ocean has exposed to its very foundations. Indeed the relations of rocks and sea are knit most intimately to the life of the people, for the eternal battle of the former has reduced to the merest remnants majestic mountains of the past over whose *disjecta membra* the cod has found a breeding place and home. Gaspé has taken its name from the very evidence of the ocean's destructiveness for, it is said, the word is derived from the term by which the Abenaqui Indians knew an isolated obelisk of rock standing on guard at the point of Cape Gaspé, towering to a hight of more than 600 feet; like, but loftier than the Old Man of Hoy which still stands on the coast of the Orkney islands, the most majestic monument in Britain to the disruptive powers of the sea. There is a singular propriety

in this country of sea-wracked topography thus deriving its name from its own wreckage.

It is a region of Appalachian folds and into the ancient troughs between them the waters of the great gulf are now again striving to enter, making the bays and barachois of the coast.

Gaspé scenery

The scenery of Gaspé county has a natural geologic basis of diversity. The eye recognizes the profound differences at once even though unconscious of their causes. The whole country is underlain by a series of great troughs and folds of the rocks running almost parallel to each other and to the shores of Gaspé bay and these project at the shore line in the majestic and ragged cliffs which form the striking and brilliant features of the coast: Whitehead, the torn cliffs of Percé, the threatening reefs of St Peter, the bold walls of Shiphead, Bon Ami and St Alban. Beneath these folds and forming the foundation on which they rest are the distorted strata of more ancient date that make the low cliffs of Cape Rosier and extend thence eastward in majestic walls all along the south shore of the St Lawrence river. Lying almost flat on top of the crests of the folds south of Gaspé bay and near the coast is an enormous mantle of brilliant red conglomerate and sandstone, rising from the base to the highest summits of Percé mountain.

If we assume to speak with precision then, these hights of Gaspé divide themselves into the true mountains wherein the rock strata have been folded, and the great dissected plateau of Percé mountain, where there has been no crumpling of the strata. Singularly enough this plateau is highest of all these hights as they now stand, save for the greater mountains of the Shickshocks in the remoter inland south of the St Lawrence river.

The Gaspé Appalachia

On this coast Appalachia still lies in contact with the sea. Its rock folds present their ends to the action of the ocean and for ages past that ceaseless agent has been gnawing them away. This is the region of the broad sweep

of the appalachian folds from southwest-northeast to north, then to east, and finally to southeast, forming the northern sigmoid horn of this mountain complex. The cliffs of Cape Gaspé are the land end of one of these folds, Point St Peter of another and Percé of still another.

The appalachian folds are not altogether above the sea level. Let the eye follow, on our hydrographic chart, the line of 30 fathoms. The cliffs of the Little Gaspé peninsula or Forillon rise 700 feet above the waters and on the northern side fall sheer to the St Lawrence. Yet at the foot of this

Grande Grève — Looking south from the King's road to the cliffs of Gaspé sandstone on the further shore of Gaspé bay; Percé mountain in the distance

inaccessible escarpment the sea bottom falls away very gradually and it is full 5 miles from the present coast line before the water reaches a depth of 180 feet. On the south, along the shore line of Gaspé bay from Indian Cove and Grande Grève to the Cape, the fall is abjectly downward from 6 and 16 fathoms to 38, 40 and 52 fathoms. Here the phenomena are the counterpart of those on the other shore. The rock strata are regularly inclined toward the waters of the bay and the waves strike only along the smooth dipping surfaces of the layers.

On this south side it is not the gnawing of the ocean that shows itself by the abrupt marine descent but a continuation of the dipping rocks carried on downward for full 300 feet indicating a recent depression of the whole land area on this side of the peninsula. The sea is indeed eating away on both sides of the Forillon, but on the north at a tremendous advantage under the fierce impact of the northeast storms.

Grande Grève — The same point of view with an elevation of the land to 50 fathoms

Let us follow the line of 50 fathoms. Fifty fathoms is less than half the hight of the rocks rising straight above the water at Cape Gaspé, and yet should the water fall away these 300 feet the land would run out into the gulf, following the direction of the mountain range until it included the rocky "American bank," into a headland of no small dimensions. Such it once was. Now washed by the waters, the home of the cod, it leaves only to the imagination the scenes of life played out on its grassy slopes during the ages before its destruction was accomplished, and while it was the outermost eastern tip of the Appalachian system.[1]

The mantle of conglomerate which lies nearly flat over the folds south of Malbay obscures the appalachian structure save where the sea has revealed it. The great fold of Percé is largely buried beneath the Devono-Carbonic rocks of Bonaventure island and Mt Ste Anne.

Appalachia in Gaspé was completed before the close of Devonic time. The folded rocks do not carry evidence of late Devonic age and the unfolded conglomerate mantle of the upper coast above their broken

[1] Mr Charles Biard, of Percé, has obtained for me samples of the rock lying on this "American" or "Green Bank" and taken at a depth of about 4 fathoms, and these prove to be entirely similar in character to the gray limestone of Cape Gaspé.

Hydrographic chart of a part of the Gaspé coast, showing lines of 30, 50 and 100 fathoms

summits can be read as deposits laid down on the open coasts of the late Devonic and perhaps early Carbonic time.

The Folds and Folded Rocks

The rocks with which we are most directly concerned are laid in secondary folds. The primary or early folds are those which find their center or protaxis about the Shickshock or Notre Dame mountains, south of the St Lawrence shore, well inland and westward of the country that now engages us. About this ridge of Precambric crystallines are the great areas of crumpled slates which are designated by the Canadian geologists Cambric and Cambro-siluric and which build the rock walls fronting the great river as far as Cape Rosier. These early paleozoic rocks in the St Lawrence valley, believed to represent strata continuing to the close of the Lower Siluric, are so irregularly disposed that their unconformity with the beds above is evident. The early upturning of the old paleozoics here did not involve the same rocks far south of the St Lawrence valley for at Percé the Siluric strata were folded up together with the Devonic, a fact which demonstrates the later age of the southern folds. The valley of the lower St Lawrence river was outlined by the primary folding but was not completed till the date of the great folds of Devonic age, which now face its southern shore on the Forillon. Nor did the folding of the Lower Siluric rocks in the St Lawrence valley involve those of later Siluric date further to the northeast, for strata of Middle and Upper Siluric age lie undisturbed on the island of Anticosti, out of the reach of appalachian disturbance.

The great rock folds of Gaspé now apparent in the topography and involving the Devonic limestones and sandstones in northern Gaspé and also the Siluric limestones and shales in the Percé region, were determined by Logan and his successors as five in number.

1 The anticlinal axis of the first or northernmost has been torn away by sea and weather but the southern limb is represented by the great limestone banks of the Forillon, the sea-gnawed remnants of majestic hills, and the course of this fold is essentially parallel to the St Lawrence river, bending from southeast to north and then to southwest in the broad curve which gives unique expression to all the appalachian courses of the region.

This limestone fold runs inland, capped with sandstone on its southern slope beyond Little Gaspé, to the far upper reaches of the Dartmouth river. From Shiphead to the head of the Northwest arm and beyond one sees the rocks constantly dipping to the south under the bay and river.

2 The Cape Haldimand anticline, the next south, is of much less amplitude than the first. The axis runs through Gaspé Basin and one may observe the sandstones here dipping steeply north on the shore of the Northwest arm, to meet at the bottom of the bay the southern limb of the Forillon fold, while on the shore of the Southwest arm they slope steeply to the south. Here Gaspé mountain is the fold and the flexure runs under the waters of the bay at Cape Haldimand. In the trough between folds 1 and 2 lies the most of Gaspé bay and along its course the Dartmouth river runs for many miles.

3 The third fold strikes the coast at Tar point opposite Grande Grève and keeps its parallel course with the others far to the mountains of the interior. Between the Cape Haldimand and Tar point anticlines lie the barachois at Douglastown and the Southwest arm of Gaspé Basin, remnants of the great sea arm that once entered the old troughs.

4 Fold number four makes its appearance on the coast at Whalehead or Point St Peter running back into the distant hills with limestone breaking through their tops, and between the Tar point anticline and this lie parts of the courses of the York river running into the Southwest arm and of the St John which empties into the barachois at Douglastown. Like other rivers in other parts of the Appalachian mountain system the Dartmouth, York and St John have the fashion of cutting their way across the folds in their newer and more active upper reaches.

5 The Malbay or Percé anticline is the southernmost of the folds and shows itself in the upturned limestones of Percé, curving inland along the southernmost stretch of limestone rocks. Between its sea end and that of the St Peter anticline lie Malbay[1] and its barachois, marking the effort of the sea to reenter this ancient trough.

[1] Malbay; anglicized and distorted French. Originally the *Baie des Molües* (in modern French, *morues*), otherwise *Codfish bay.*

Photo by A. H. Dolbel

Cape Rosier; showing the low, leveled cliffs of upturned Cambric slates underlying the Devonic limestone series of the Forillon

On the backs of all these major folds rise lesser ones and at Percé the chief fold has been completely broken down and its parts displaced, as shown in the Murailles, the sea wall at Corner of the Beach and the cliffs of Cap Blanc. This southernmost fold, unlike those farther north, seems to have involved not alone the Devonic rocks but the Siluric strata beneath. We shall observe in noticing specially the geologic structure at Percé, that the coast rocks, part of which are lower Devonic, part Upper Siluric, and part Lower Siluric stand all in slightly overturned attitude, the lower leaning over against the higher toward the north and their strata all essentially parallel. This southernmost of the parallel folds carried with it rocks not before disturbed in previous upturnings. The Siluric strata of Cape Rosier and thence westward on the St Lawrence were folded, broken and eroded before the Forillon (axis 1) was made. Southward the Siluric rocks may have escaped the folding to which they were subjected at the north till both they and the Devonic rocks above were raised near the end of Devonic time.

It may hardly do to say that all the bays of Gaspé are the residua of the ancient encroachments of the sea into the old rock troughs but they demonstrate the old topography most effectually. The entrance of the gulf waters into these troughs has been aided by the depression of the coastal region and it seems quite probable that the present outlines of Gaspé bay and the barachois at Douglastown and Malbay, though indicating and lying in these ancient rock troughs, are of comparatively recent date.[1]

[1] At Gaspé Basin there are elevated beaches facing the Dartmouth river and also seen at Lobster point. The present upward tendency of the land movement is likewise indicated by the shoaling of the Northwest and Southwest arms which in their broad upper reaches are tidal flats through which the currents of the rivers steer an uncertain course. The increase in the sandbars across the upper end of Gaspé bay, the long sandspit of Sandy Beach on the south, the broad triangle of Peninsula on the north and the growing difficulties for vessels in keeping a clear passage through the narrow channel between the two, is evidence of like import. The widening of the great bar of the Barachois of Malbay and the shoaling of its inlet streams have a similar bearing.

At Percé, I learn from personal inquiry that there has been a slow but general rise of the land in the last 50 years but that within the memory of some of the older inhabitants this is a reversal of a downward movement. Just before that date the drying stages

Barachois, bar and tickle

With singular uniformity the bays of all the Gaspé coast facing the Gulf of St Lawrence and the Bay of Chaleurs are equipped with bars which nearly sever them from the sea. The traveler by land from Gaspé Basin southward through Douglastown and the Malbay, by Little Pabos and Grand Pabos, passes down one arm of the bar, is ferried over the narrow sea passage or "tickle" and continues his journey along the other arm of the bar; with the tide coming in or rushing out or by heavy weather, the passage across the tickle is ticklish indeed. There is a tickle in every bar and the term is even applied to the inlet waters entering the bay behind, as at Malbay where there is a *Tickle inlet.* I am assured that this term has its origin in the subjective sensations of the traveler, as I have suggested, though it is suspicious of other derivation. On the Newfoundland and Cape Breton coast its use seems to be somewhat broader in application to a broken rock reef and the channels through it. The barachois is the area of semiimpounded lagoon waters behind the bar, a *Haff* on the Prussian Baltic, and may well express that type of coastal lagoon whose existence is in large part due to the inflowing of river waters. Barachois is a Canadian word which according to the Abbé Ferland is derived thus: *barre-à-cheois,* that part protected from the tumble of the waves. It occurs to me that it might be from *barre-eschué* (*eschuer,* old French = to shun, avoid or escape from).

In the barachois of an ancient date the great deposits of much of the Gaspé sandstone were laid down.

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on the beach were deserted as the sea encroached and overwhelmed them but today the posts of these old stages are revealed as the beaches come up and the new stages are again creeping down to the position of their predecessors.

If we should choose to plot these present evidences of rise and fall of the crust it would appear that an axis of elevation runs from Percé through the head of Gaspé bay and northwestward to Grande Vallée on the St Lawrence with a trough of depression eastward thereof. It would not be far from parallel with the course of Gaspé bay nor a wide deviation from the trend of the rock anticlines.

Historical note

At this point I desire to state in summary the personal obligation which the geologist in the Gaspé country must feel to his predecessors in the same field.

Sir William E. Logan, first director of the Geological Survey of Canada, entered the region when it was without roads, and only its coasts were settled here and there by fisherfolk. Guided by Indians on land and by water, he sought and found the key to the geologic structure of the country; and so conclusively and with such admirable finish was the work of this master hand accomplished that in all the years since elapsed from 1844 and 1845 little has been added to, and naught subtracted from his achievements. The problems of geologic structure were not, indeed, complicated, but they were and continue with growing importance to be of far-reaching significance. Like Hall in the Fourth district of New York, he builded better than he knew and as that region has become classical in the paleozoic geology of America because of the simplicity of its phenomena and profusion of its ancient faunas, so the Gaspé country, unsurpassed in the brilliancy and fulness of its presentments, will always be a monument to the prowess and genius of this great Canadian. Logan determined the succession of the rocks and classified them by name and contents; he elucidated the structure of the country, determined the character of the folding, tracing the axes of the folds from coast inland, and executed a triangulation survey. With Sir William in these early days was associated Mr Alexander Murray. In 1857 and 1858 the survey was continued by Mr James Richardson and in 1862 by Robert Bell, now chief geologist of the Dominion Survey. In

Logan

1863 Sir William issued the *Geology of Canada* which embodied in continuous discussion the results achieved by himself and his assistants. To a student of Gaspé geology this is the compendium and guide. There is left for future workers in this field only the elaboration of structural and physiographic details and the refined exploitation of the stratigraphy and paleontology.

A reexamination of the stratigraphy of the country was made by Dr R. W. Ells and Mr (now Director) A. P. Low for the Survey and reported in 1883–4. To this later work we also owe much; it recorded new localities of interest, it followed new traverses across the interior and determined with still more accuracy the direction of the fundamental folds and troughs; it analyzed with care and keenness the composition of the deposits lying over the folded rocks, and finally resulted in the production of a very helpful and trustworthy map of the entire peninsula.

The invertebrate fauna of these ancient rocks so far as it has been made known till today, was chiefly described by Elkanah Billings, Paleontologist to the Canadian Survey. Here, as in all the work of this keen investigator, there is the evidence of unrelaxed exactitude which has given to his determinations perpetual value. It is our good fortune to be able to cite his work so frequently that our pages may almost seem its memorial.

Sir William Dawson also contributed most importantly to the paleontology of the region, but confined his descriptions mainly to the terrestrial plant remains of the Gaspé sandstone; Prof. E. R. Lankester described some fish remains and Dr Henry Woodward a crustacean submitted by Dawson, from the plant beds of the same formation. To Dr H. M. Ami we owe observations on the invertebrate fauna and stratigraphy of the region.

On entering this field, remote from New York but geologically a part of it, it was with the expressed approval of the lamented Dr George M. Dawson, then director of the Geological Survey of Canada. It was a source of much gratification to the writer that this effort to acquire new light for his own State should not be regarded an invasion but rather applauded and encouraged. And in the same generous spirit of approval and helpfulness has this work been recognized by the present chief geologist, Dr Bell,

and his associate Dr J. F. Whiteaves, paleontologist of the Survey. I take this occasion to express the sense of satisfaction and comfort which has, from a consciousness of this attitude of the Canadian officials, attended the execution of the work.

My first visit to this field and to the remarkable localities at Dalhousie N. B. was in the company of Prof. Charles Schuchert. It had been Professor Schuchert's plan to elaborate some part of the series of fossils then brought away, but in the pressure of other duties he relinquished this purpose and has placed in my hands all his acquisitions, the property of the National Museum. In subsequent years there have been frequent other trips by me to this field and large additions of material, so that the following observations may be considered as based on somewhat extensive data. Yet I must assure myself and my readers that the facts here brought together are but suggestions for future study of this fertile field.

If I were here to express my obligation to all residents of the Gaspé settlements who through kindly interest and assistance have forwarded my labors, the list would be a long one. I can not however refrain from personally acknowledging in some measure the aid from Mr A. H. Dolbel of the William Fruing Co., Daniel Gavey and Mr Lehuquet at Grande Grève, Commander Wakeham and Hon. A. F. Dixon, U. S. Consul, of Gaspé Basin, Messrs Charles Biard, Richardson Tardif, Philip LeBoutillier, of Percé and the late Philip Mauger, of Bonaventure Island. The list would be incomplete without a special acknowledgment to the late Mr Frederick James of Percé to whose artistic achievement and personal consideration I am indebted for several of the views in color here given, and to Capt. L. R. Demers (*integer vitæ scelerisque purus*) of the Quebec Steamship Co. whose wide knowledge of all the coast and keen appreciation of scientific fact and endeavor has been most helpful.

GEOLOGY OF THE FORILLON

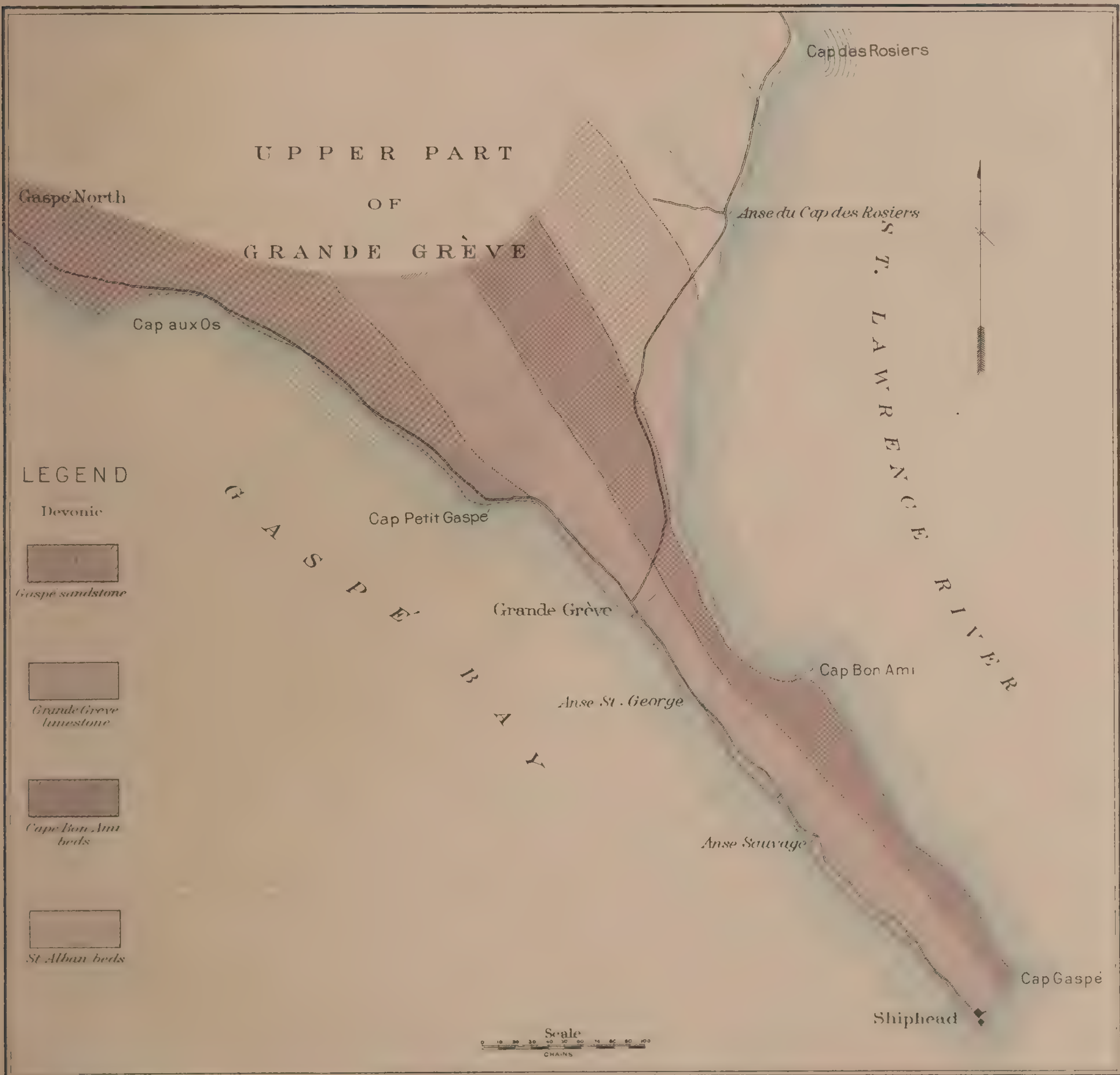
The first of Sir William Logan's endeavors as director of the Canadian survey was by boat and portage to decipher the structure of this little peninsula which lies between the St Lawrence river and Gaspé bay. The display of the rock succession here and its profusion in organic remains will assure its perpetual attraction to the student of geology.

Sketch of Grande Grève looking west, the Fruing and Hyman fishing stations in the foreground, the promontory of Little Gaspé in the middle distance. At the right the slope of the hills is approximately the same as the dip of the limestones and the mountains in the background express the same feature.

From the broad fist of Rosier cape and cove this spine of land runs out into the sea like an index finger, as it might say to the observer of Gaspé scenery

☞ *Mark well her bulwarks*

It is but a remnant saved from the destruction of the waves and, barely a half mile across at the portage above the Grande Grève, it is not only going down, but being devoured as it goes. Its rib of mountains



Base from Crown Lands map

Geology by J. M. Clarke

Geological Map of the Forillon, Gaspé

is the still mighty flank of a mightier range. One may here start at the waters of Gaspé bay and climbing upward, a short half hour will bring him to the cliffs of Bon Ami, 700 feet straight over the waters of the St Lawrence river; off at his left above the curve of Rosier Cove towers bare St Alban, 1100 feet, the highest point reached by these rocks in their upward inclination toward the north. If he will take the King's road, which traverses the peninsula from Grande Grève to Cape Rosier, it will lead him at first gently through a way embowered in evergreens and bring him out with startling abruptness almost to the hight of the Bon Ami cliffs. Lying on his belly on the grass of the roadside, he may test his nerve by watching the waves break at the base of the concave cliff, hundreds of feet below him. Mount St Alban rises again at his left, a gray bare rock wall on its sea front, embrasured in a sloping talus of its own fragments and resting on a projecting rock point, the Quay, at the edge of the water. St Alban seems the very genius of the place, a stern, weather-beaten god, skirted in his kirtle of fallen rocks, with foot planted forward on the strand, bidding an impotent defiance to the onrushing waves like another royal Knut who himself may have to take place among the myths of geology as a like imposing sea cliff. The King's road, reaching the summit of the cliffs, becomes thence well nigh impossible, pitching downward at an unknown angle, but it comes out at last after many tribulations to the traveler, to the broad, flat triangle of Cape Rosier where rest the upturned Cambric slates beneath the great limestone series of which we are about to speak.

Some of the earliest French explorers, perhaps Champlain, termed this narrow peninsula, this spine of land, the Forillon.[1] In early maps and in the *Jesuit Relations* the name, often spelled *Fourillon*, is attached only to the cape now called by the English Shiphead. Out at the end of Shiphead stood the obelisk of rock which the sea had separated from the

[1] Describing the hills and headland of this peninsula, Nicholas Denys (1672) says: "Cette pointe se nomme le Forillon, il y a une petite Isle devant ou les pecheurs de Gaspé viennent faire leur degrad pour trouver la molüe." Description géographique et historiques de Costes de l'Amérique septentrionale. Avec l'histoire naturelle du Pais. p. 234

cliff. To this the name Forillon was vicariously applied, the name of the whole being taken for the part. The obelisk was also to the French, *La Vieille*, the Old Woman which, says the Abbé Ferland, with its tufted cap of verdure, resembled some of the Canadian grandmothers. It is a fallen woman now, for it went down in a heavy sea in 1851; Admiral Bayfield put it on his charts as the *Flowerpot* and so it stands today on English maps. We have referred to this obelisk as having perhaps furnished to the Indians the name for the whole Gaspé country. It has been suggested that Forillon may be derived from *forer*, to drill or bore, as one should say, a drill, and

The Forillon from beyond Peninsula to the cape; showing the character of the sky line. Grande Grève about 1 inch from the land's end. Taken from the hills back of Gaspe basin, 16 miles from the cape

certainly this long narrow spine upon the charts might well suggest such a name. Others would construe the term as referring to the piercing of the end of the cape by the parting of the obelisk, and have the word apply to that only. Be this as it may, the obelisk is gone and naught remains but the Flowerpot. In recalling the term Forillon for this Gaspé spine of land we return to an ancient usage and in so doing find a needed geographic name.

High on the broad southward slopes of the Forillon are scattered some

of the serenest and most contented of homes; their farms, pitched at angles of twenty to thirty degrees to the water, yield their slender increase, the crest of spruce and fir adds softness and beauty to every contour. From these homes the eye sweeps over a magnificent stretch of bay and sea and never tires at the infinitude of variety in the scene. The observer seems to view the panorama spread before him as do the sea mews wending their way from their roost on the Bon Ami cliffs to the feeding grounds in the barachois at Douglastown. The whole stretch of Gaspé bay lies before the eye from the hillside galleries. Far away at the west are the rounded sandstone mountains of Gaspé Basin, besmudged and screened by the smoke clouds from the lumber mills at the great sand bar. Here the panorama begins and under the circling eye pass in due succession the low cliffs of Douglastown, its sand bars, its tickle and barachois lying low to the water line, the reddish timbered hills of Bois Brulé and the crimson sea wall of sandstone running on eastward to Point St Peter, the end of the south shore save for the little lighthouse crowned Plateau Island at its tip. Above these lower hights of the foreground rise at the east the graceful curves of majestic Percé mountain, 24 miles away as the cormorant flies, crowned at the summit with the

Looking south from Shiphead at the entrance of Gaspé bay; showing Point St Peter, 10 miles, Bonaventure island and Percé mountain, 18 miles

shrine of Ste Anne. Looking from the higher summits of the Forillon, the Percé Rock slips above the horizon and from Shiphead light at the tip of the Cape one sees Bonaventure island stretched out full length; beyond them all the great expanse of gulf waters.

Gaspé limestones of Logan

Sir William's subdivision of the limestone series which has its base at Cape Rosier Cove on the north and whose uppermost beds skirt the coast of the Forillon from Little Gaspé to Shiphead, is here given in full in ascending order as presented in his *Geology of Canada* [1863, p. 391].

		FEET
1	Gray limestones in layers of from six to eight inches thick, which are separated by bands of greenish calcareo-argillaceous shale, gradually increasing in amount towards the upper part. The limestone beds abound with fossils, and contain, among other species, large crinoidal columns, Favosites gothlandica, F. basaltica, F. cervicornis, with undetermined species of Zaphrentis, Dictyonema and Fenestella, two undetermined species each of Lucina and Strophomena, with S. rhomboidalis, S. punctulifera, two or three undetermined species of Orthis, Rhynchonella acutiplicata, two or three species of Orthis, Pentamerus galeatus, three undetermined species of Spirifera, Athyris laevis, Atrypa reticularis, Cyrtodonta orbicularis, C. lata, C. flexuosa, Modiolopsis cultrata, Avicula bronni, A. naviformis, Loxonema gaspensis, L. gracilis, Bellerophon laurenticus, two undetermined species of Platyceras, an undetermined Conularia, with several undetermined species of Orthoceras, Dalmanites pleuroptyx, an undetermined Phacops, Bronteus canadensis, and an undetermined species of Beyrichia - - - - - - - - - - - - - - -	70
2	Greenish calcareo-argillaceous shales, which are interstratified with less calcareous layers, of various shades of red. The only fossils observed, occur about the middle of the deposit, and consist of flattened stems of marine plants, apparently replaced by oxid of iron - - - - - - - - -	90
3	Olive-green calcareo-argillaceous shales, with occasional nodules and layers of compact limestone; the former from an inch to a foot in diameter, and the latter from six inches to two feet thick. Some of the layers are rather arenaceous; remains of fucoids occur at the top - - - - - - - -	170
4	Gray limestones in thin beds, separated by gray calcareous shales, of which there are more towards the bottom than the top. The whole mass is interstratified with three or four bands of olive-green calcareo-argillaceous shale. About fifty feet from the bottom, there is a bed of seven feet, made up of several thin layers of limestone and limestone shale, and presenting a singularly wrinkled structure, from which the beds above and below are free. It would appear as if the layers, after their deposit, had been contorted by lateral pressure, the underlying stratum remaining undisturbed, and had then been worn smooth, before the deposition of the next bed. Where the inverted arches of the flexures occur, some of the lower layers are occasionally wanting; as if the corrugated bed had been worn on the under as well as the upper side. The corrugations are precisely in the direction of the dip, and the peculiarity is	

	FEET
not confined to a small part of the deposit, for the same thing is observed at the Petit Portage and Cape Bon Ami, the only two localities in which these limestones have been observed; these are upwards of a mile asunder. The fossils of these calcareous strata are not so numerous as those of the limestones at the base of the section. Among them however are fucoids or compressed stems of plants, an undetermined species of Chonetes, Leptocoelia concava, L. flabellites, Spirifera crispata, with undetermined species of Conularia and Orthoceras - - - - - - - - - - -	200
5 Gray or slighly greenish calcareous shales, associated with bands of dark gray. Both are interstratified with layers of arenaceous limestone, which are occasionally sufficiently coarse grained to approach the character of a fine conglomerate. Fossils are somewhat abundant; in addition to marine plants, which are chiefly confined to long flattened serpentining stems, the species which prevail are two undetermined species of Lucina, and two of Lingula, Strophomena rhomboidalis, an undetermined Chonetes, Leptocoelia concava, L. flabellites, and Spirifera crispata, with two undetermined species of Orthoceras and one of Phacops - - - - - - - - - - -	380
6 Gray calcareous shales or shaly limestones, interstratified, particularly at the top, with thin beds of purer limestone fit for burning. The organic remains of this part, which do not appear to be abundant, are chiefly obscure serpentining fucoids; which are accompanied by species of Lingula, Discina, a Conularia resembling C. sowerbyi, and an undetermined species of Pterygotus - -	300
	1210

These strata dip southwest, at an angle of 24°, and are beautifully seen in the cliffs; which present a vertical naked face nearly 700 feet in hight, on the northeast side of Gaspé promontory. The lowest limestones, 1, constitute the first step in the ascent to the mountains encountered in passing from Cape Rosier to Grande Grève. The second hard calcareous band, 4, forms another step in the same ascent; it makes also Cape Bon Ami, from which the gray calcareous shales, 5, present a deep slope up to the foot of the gray shaly limestone, 6. These rise in a vertical and sometimes overhanging escarpment, up to the edge of the precipice; from which the harder beds that form the summit of the above section, slope down into a valley. This valley divides the hills of the promontory into a double range, and maintains its character with some constancy, farther into the interior.

From this valley, the succeeding members of the series are piled in a second escarpment, and constitute the loftier of the two ranges: these strata, as before, dip S.W. $< 24°$ and are, in ascending order, as follows:

	FEET
7 Gray nodular shaly limestones, succeeded by gray limestones of a purer nature; these are followed by a second series of beds like the first, on which rest greenish calcareo-arenaceous shales, terminating in a thin layer, which is nearly grass-green. A fossil strongly resembling Fucoides cauda-galli, is common throughout the deposit, and some surfaces are almost completely covered by it; the only species observed accompanying it was Dalmanites pleuroptyx -	300
8 Gray limestones fit for burning, in beds of from six to twelve inches thick, some of them holding chert at the summit. Fossils abound; among the species are Fucoides cauda-galli, Favosites gothlandica, F. basaltica, F. cervicornis, two undetermined species of Zaphrentis and one of Fenestella, Orthis oblata, with two or three undetermined species of this genus, Strophomena rhomboidalis, S. becki, S. perplana, with two undetermined species of Strophomena, three	

	FEET
undetermined species of Chonetes, and two of Rhynchonella, with R. acutiplicata, Leptocoelia concava, L. flabellites, Eatonia peculiaris, Rensselaeria ovoides, two undetermined species of Spirifera, with S. arenosa, Atrypa reticularis, Athyris laevis, two undetermined species of Modiolopsis and two of Avicula, with undetermined species of Murchisonia, Pleurotomaria, Loxonema, Orthoceras, Phacops, and Proetus, with Dalmanites pleuroptyx - - -	500
	800

The entire volume of these Upper Silurian limestones would thus be about 2000 feet. They occupy the whole of the promontory of Cape Gaspé, which extends from the mainland for a distance of about 7 miles, with a breadth of no more than seven-tenths of a mile; except at its junction with the lowland extending to Cape Rosier, where it gradually assumes a greater breadth. They skirt the northeast bank of the northwest arm of Gaspé bay, and the left bank of Dartmouth river; constituting a range of mountains, some of whose summits, according to Bayfield, are about 1500 feet high. From Little Gaspé, they are flanked by a strip of the succeeding formation, the junction of the two being seen in Little Gaspé cove. About 17 miles above Little Gaspé, these limestones cross the north branch of the Dartmouth, upwards of 2 miles from the mouth of the tributary; on which a partial section, directly across the measures, presents a thickness of 1800 feet. At the bottom of this, there are interstratified layers of chert, which have not yet been observed at Cape Gaspé.

The determinations of fossils appearing in this table were provisionally made by Mr Billings, who afterward described in some fulness 42 species of the higher beds but perfected his determination of the species of the lower beds, 1–7, in 10 cases only.

The passage of these beds from bottom to top, one into the next, is altogether gradual and without interruption. In a general survey of the great series of limestones, the lithic change is expressed in a tendency upward to greater purity of limestone and chert deposits. With this increase of purity the fauna becomes much more prolific and the upper beds redound in fossils while in the lower divisions they are relatively rare. The intermediate divisions from 2 upwards to 5 are comparatively barren while in 1 more species are to be found. We have felt obliged to base any subdivision of these 2000 feet of limestone chiefly on data that we have ourselves been able to bring together. One can not be guided here entirely by the determinations of fossils in Logan's scheme, for there are in his lists suggestions of species which Billings in his final report failed subsequently to record and our own collections contain many forms which are not indi-

cated on those lists. We shall, therefore, make our way with the best light at our command.[1]

Logan regarded this entire series of beds as "Upper Silurian limestones" [*loc. cit.* p. 393] or more definitely "a great development of strata of the age of the Lower Helderberg group" [p. 391]. The closer scrutiny of the fossil contents led Billings to conclude that "the two lower divisions [1 and 2] are most probably Silurian; about the age of the Helderberg of the New York geologists. The upper two members [7 and 8] are nearly of the age of the Oriskany sandstone, and are therefore about the base of the Devonian. Divisions 4, 5 and 6 may be regarded as constituting passage beds between the Upper Silurian and Devonian."[2]

Ells (1883) states that "of these Gaspé limestones it is now considered that only the two lower members, representing a thickness of 160 feet, can with propriety be assigned to this [Siluric] system while the preponderance of fossils of Devonian aspect even in the basal bed renders it probable that the whole may ultimately be transferred to the Devonian system."[3]

This farsighted view has foreshadowed that at which we have arrived with the aid of detailed and conclusive evidence.

On a previous occasion we have briefly discussed the relation of the fauna as a whole to the series in New York,[4] and at that time made the following propositions:

Logan's subdivision of the limestone series was given with lucidity and exactitude but seems hardly to clothe this unique succession with the dignity and importance it merits. Dr Ami has suggested that the upper beds 7 and 8, be termed the *Grande Grève limestones* from the little village on the peninsula where these strata are best exposed and most readily accessible. . . . This name seems happily chosen and we have thought that with equal propriety the lower beds 1 and 2, exposed in the

[1] Dr Whiteaves has made it possible for us to institute comparisons with Billings's original specimens whenever doubt has arisen concerning the identity of our own material, and to refigure in many cases these types.

[2] Paleoz. Foss. 1874. v. 2, pt 1, p. 2.

[3] Rep't Geol. Gaspé Penin., Geol. Sur. Can. Rep't Prog. 1880–82. 1883. p. 15 DD.

[4] N. Y. State Mus. Mem. 3. 1900, p. 81.

base of Mt St Alban along the shore of Cape Rosier cove on the St Lawrence may be called the *St Alban limestones*, while the passage beds of Billings (no. 3, 4, 5 and 6) which are displayed in the fine 700 foot vertical escarpment at Cape Bon Ami west of Cape Gaspé, may receive the name of *Cape Bon Ami limestones.*

It appears that Dr Ami's suggestion referred to above was not published till 1902[1] and he states briefly that "la formation Grande Grève contient des fossiles qui sont équivalents á ceux de la formation Oriskany de l'ouest."

We shall do well, therefore, to consider the Grande Grève beds as inclusive of all embraced in Logan's divisions 7 and 8.

In treating of those subdivisions we shall for the present confine ourselves to their development on the Gaspé Forillon. It is here that they are typically exposed. Subsequently we shall refer to their manifestation at other points so far as they have been observed.

St Alban beds

Logan's divisions 1 and 2

The exposures of this division lie in the base of St Alban mountain which towers to a hight of 1100 feet in sheer declivities above the shore of Cape Rosier cove. One reaches these beds by traversing the King's road from Grande Grève, following its precipitous descent from the top of the sea wall, where the waters beat at the foot of the concave cliff 600 feet below, down to the lower levels and across the country to the shore. All but the shore outcrops are here concealed in the great mass of overlying strata. The exposures are nearly along the dip of the strata for the trend of the coast is more northerly here than elsewhere. The strata rest on the upturned "Cambro-Siluric" slates of Cape Rosier which of themselves make an inconspicuous element in the topography of the region. Their stratigraphic characters are sufficiently described in Logan's characterization. Messrs. Barlow and Giroux made collections in 1883

[1] Equisse géologique du Canada, p. 33. Extracted from the *Naturaliste Canadien* of 1901–2.

from Cape Rosier at the contact with the rocks of the "Quebec" group and the following species are cited in Ells's Report, 1884 (p. 30E)

Favosites gothlandica

Leptocoelia flabellites

Strophomena punctulifera

View from near the summit of the Bon Ami cliffs looking into Rosier cove, Cape Rosier in the distance; the beds of the St Alban and Bon Ami divisions exposed on the shores

Pterinea textilis Hall

Spirophyton cauda-galli

Sir William Logan notes the occurrence of fossils in the upper reaches of Griffon Cove river[1] at what he has termed the *Ruisseau de la Grande Carrière*, 10 miles west up the Forillon. The highway which leads over the divide along this river and the King's road at Grande Grève are the only roads that cross the Forillon from south to north. We have visited these outcrops and observe that the pass is called by the people of the peninsula, the Grande Cavée of Griffon Cove river; by which term we also

[1] L'anse au gris fond; the *Griffon* is a purely English creation.

prefer to designate it. Dr Ells has recorded the same occurrence and states[1] that the strata here "are very near the contact with the rocks of the Quebec group and the fossils are from the lower division of the limestone series." In the short section there presented we find at the base heavy beds of quartz conglomerate ("Quebec"?) followed above by arenaceous limestones and over these more schistose limestones. Both of the latter carry fossils which unquestionably pertain to the fauna of the St Alban beds and are quite devoid of characters which would closely ally them to the higher or Grande Grève fauna.

Some of the beds in this Griffon Cove river section, which we may not have seen, Logan regarded as the summit of the Gaspé series, and we may therefore specify that those examined by us and from which the fauna here cited was obtained are in the vicinity of the highway bridge over the river about three miles in from the south shore.

Fauna of the St Alban beds

Some incongruities appear in the comparison of published lists of the fossils of these beds given by Billings[2] and Ami, and those based on the materials we have collected and here described. The differences are more apparent than real and are probably due in part to the fact that those in Logan's work were only provisional and subject to revision, and it is also possible that Messrs Billings and Ami had species which may not have come under our observation. In citing Logan's classification of the rock series we have given the fossils as quoted by him and these we bring together again for purposes of comparison; in this list comparisons or identities with our own material are suggested [second column].

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[1] Rep't for 1882. p. 7 DD.

[2] We assume that the determinations cited by Logan in his classifications were made by Billings.

Photo by A. H. Dolbel

The vertical cliff of Mt St Alban — St Alban and Bon Ami beds. Taken from the summit of the King's road near the telegraph pole in the lower left corner. The course of this road at the foot of the mountain is seen at the right

Fossils of divisions 1 and 2 as given by Logan (Billings): *Geology of Canada*

Favosites gothlandica F. basaltica F. cervicornis	Favosites helderbergiae *Hall* F. *cf.* gaspensis *Lambe*
Zaphrentis	Z. rugulata *Billings*
Dictyonema	D. splendens *Billings*
Fenestella	
Lucina	
Strophomena	
S. rhomboidalis	Leptaena rhomboidalis *Wilckens*
S. punctulifera	Strophonella punctulifera *Conrad*
Orthis, several species	Dalmanella subcarinata *Hall* D. *cf.* discus *Hall*
Rhynchonella acutiplicata *Hall*	Camarotoechia *cf.* altiplicata *Hall*
Pentamerus galeatus (*Dalman*)	Gypidula galeata (*Dalman*)
Spirifer	S. perlamellosus *Hall?*
Athyris laevis	Meristella laevis *Hall*
Atrypa reticularis	A. reticularis (*Linné*)
*Cyrtodonta orbicularis[1]	
*C. lata	
*C. flexuosa	Cypricardinia planulata *Hall?*
*Modiolopsis cultrata	Modiomorpha varia *Billings?*
*Avicula bronni	Limoptera rosieri *nov?*
A. naviformis *Conrad*	
*Loxonema gaspensis	Pleurotomaria labrosa *Hall?*
*L. gracilis	
*Bellerophon laurenticus	
Platyceras	
Conularia	C. lata *Hall*
Orthoceras	Kionoceras *cf.* rhysum *nov.*
Dalmanites pleuroptyx	Dal. coxius *nov?*
Phacops	Ph. logani *Hall?*
*Bronteus canadensis	B. barrandii *Hall*
Beyrichia	B. kloedeni *var.* acadica *Jones*

At the Grand Cavée of Griffon Cove river the species collected by Ells (1882), Barlow and Giroux (1883) and identified by Ami are as follows:

Favosites	
Zaphrentis cingulosa *Billings*	Described from Percé rock
Strophomena punctulifera *Conrad*	
S. rhomboidalis	
S. inaequiradiata *Hall*	S. patersoni precedens *nov?*
S. blainvillei *Billings*	A Gaspé sandstone species
S. perplana *Conrad*	Leptostrophia magnifica *Hall?*
Orthis aurelia *Billings*	Described from Grande Grève limestones
Atrypa reticularis *Linné*	
Athyris (Merista) arcuata *Hall*	Meristella laevis *Hall?*
Meristella cf. laevis Hall	

[1] Names starred appear to be *nomina nuda*.

Lingula lucretia *Billings*	Described from Cape Bon Ami
Spirifer cyclopterus *Hall*	
Pteronitella venusta *Billings*	Described from Arisaig
Anodontopsis	
Orthoceras	
Illaenus	
Dalmanites anchiops / D. pleuroptyx *Green*	D. griffoni *nov.*

We assume that this last list was intended more as a suggestion of identities than as positive determinations as its species range from the late Siluric to middle Devonic.

It has seemed well to take up the detailed notice of the fossils of the entire series of the Gaspé limestones under a special chapter but we may here summarize the species of these St Alban beds as represented in our material.

From Cape Rosier Cove

Bronteus barrandii *Hall*
Cordania cyclurus *Hall & Clarke*
Cyrtoceras albani *nov.*
Conularia lata *Hall*
Probolaeum ? canadense *nov.*
Pleurotomaria labrosa *Hall*
Limoptera rosieri *nov.*
Palaeopinna flabellum *Hall*
Mytilarca nitida *Billings*
Leptodomus canadensis *Billings*
Cypricardinia planulata *Hall*
Goniophora mediocris *Billings*
Modiomorpha varia (*Billings*)
Camarotoechia *cf.* altiplicata *Hall*
C. semiplicata (*Conrad*)
Sieberella galeata (*Dalman*)
Nucleospira ventricosa *Hall*
Rhynchospira globosa *Hall*
R. formosa *Hall*
Meristella laevis *Hall*
Atrypa reticularis *Linné*
Atrypina imbricata *Hall*
Spirifer perlamellosus *Hall ?*
Orthothetes woolworthanus *Hall*
Strophonella punctulifera (*Conrad*)
Stropheodonta patersoni precedens *nov.*
S. rosieri *nov.*
Leptostrophia magnifica *Hall*
Leptaena rhomboidalis (*Wilckens*)
Orthostrophia canadensis *nov.*
Dalmanella *sp. cf.* concinna *Hall*
D. subcarinata *Hall*
Pholidops ovatus *Hall*
Dictyonema splendens *Billings*
Zaphrentis shumardi *E. and H. ?*
Favosites helderbergiae *Hall*
F. *cf.* gaspensis *Lambe*
Spirophyton
Alga

From the beds at the Grande Cavée of Griffon Cove River

Phacops logani *Hall*
Dalmanites griffoni *nov.*
Kionoceras *cf.* rhysum *nov.*
Lophospira bilirata (*Hall*)
Eotomaria cartieri *nov.*
Actinopteria textilis (*Conrad*)
Leptodomus canadensis *Billings*
Goniophora mediocris *Billings*
Modiomorpha varia (*Billings*)
Camarotoechia semiplicata (*Conrad*)
C. *cf.* altiplicata *Hall*
Uncinulus vellicatus *Hall*
Atrypina *sp.*
Strophonella leavenworthana *Hall*
Leptostrophia becki *Hall*
Leptaena rhomboidalis (*Wilckens*)
Orthostrophia canadensis *nov.*

Photo by Charles Schuchert

The cliffs of Rosier cove—St Alban beds; viewed from the St Lawrence river

There is a notable community of species in these two localities. In the following tabulation this is indicated and together therewith the occurrence of these species and close allies thereof in other formations.

SPECIES	ST ALBAN BEDS							
	1 Cape Rosier cove	2 Grande Cavée	3 Cape Bon Ami beds	4 Grande Grève beds	5 Helderbergian N. Y.	6 Calcareous Oriskany N. Y.	7 Arenaceous Oriskany N. Y.	8 Dalhousie beds
Phacops logani *Hall*	...	x	....	x	x	x	..	x
Dalmanites griffoni *nov.*	....	x	....	....	(x)			
D. coxius *nov.*	?							
Bronteus barrandii *Hall*	x	....	....	....	....	.	..	(x)
Cordania cyclurus *H. & C.*	x	....	...	..	x	x		
Kionoceras *cf.* rhysum *nov.*	....	x	x	x				
Cyrtoceras albani *nov*	x	....	..	....	(x)			
Conularia lata *Hall*	x	....	...	x	....	...	x	
Probolaeum ? canadense *nov.*	x							
Pleurotomaria labrosa *Hall*	x	...	....	....	x			
Lophospira bilirata (*Hall*)	...	x	....	....	x			
Eotomaria cartieri *nov*	....	x						
Actinopteria textilis (*Conrad*)	....	x	...	....	....	x	x	
Limoptera rosieri *nov*	x							
Modiomorpha varia (*Billings*)	x	x	...	x				
Goniophora mediocris *Billings*	x	x	...	x				
Leptodomus canadensis *Billings*	x	x	...	x				
Mytilarca nitida *Billings*	x	....	...	x				
Palaeopinna flabellum *Hall*	x	....	..	x	....	...	x	
Cypricardinia planulata *Hall*	x							
Camarotoechia semiplicata *Conrad*	x	x	....	..	x			
C. *cf.* altiplicata *Hall*	x	x	....	....	x			
Uncinulus vellicatus *Hall*	....	x						
Sieberella galeata (*Dalman*)	x	....	....	....	x	....	...	**x**
Atrypa reticularis *Linné*	x	..	....	....	x	....	...	**x**
Atrypina imbricata *Hall*	x	...	...	....	x			
A. sp	....	x						
Nucleospira ventricosa *Hall*	x	....	....	....	x			
Rhynchospira globosa *Hall*	x	..	....	..	x			
R. formosa *Hall*	x	....	....	..	x			
Meristella laevis *Hall*	x	....	x	..	x			
Spirifer perlamellosus *Hall?*	x	....	....	....	x	....	....	**x**
Stropheodonta patersoni precedens *nov.*	x	..	....	x	....	....	....	**x**
S. rosieri *nov*	x							
Leptostrophia magnifica *Hall*	x	...	...	..	....	x	x	**x**

SPECIES	ST ALBAN BEDS: 1 Cape Rosier cove	ST ALBAN BEDS: 2 Grande Cavée	3 Cape Bon Ami beds	4 Grande Grève beds	5 Helderbergian N. Y.	6 Calcareous Oriskany N. Y.	7 Arenaceous Oriskany N. Y.	8 Dalhousie beds
L. becki *Hall*	....	x	..	...	x	....	..	x
Leptaena rhomboidalis (*Wilckens*)	x	x	x	x	x			
Strophonella punctulifera (*Conrad*)	x	....	....	...	x			
S. leavenworthana *Hall*	....	x	....	....	x			
Orthothetes woolworthanus *Hall*	x	....	....	..	x			
Orthostrophia canadensis *nov*	x	x	....	....	(x)			
Dalmanella subcarinata *Hall*	x	....	....	....	x			
D. *cf.* discus *Hall*	x	...	...	...	x	x		
Pholidops ovatus *Hall*	x	....	....	....	x			
Dictyonema splendens *Billings*	x	....	....	....	x	....	....	x
Zaphrentis shumardi *M-E. & H.*	?							
Favosites helderbergiae *Hall*	x	...	....	....	x			
F. *cf.* gaspensis *Lambe*	x							
Alga	x							
Spirophyton *cf.* cauda-galli *Vanuxem*	x							
	37	17	3	10	(27)	5	4	(9)
The correlation value of this fauna is apparent: The assemblages of species at Cape Rosier Cove and Griffon Cove river have seven forms in common; the entire fauna as known is constituted of 50 (48) species, of which about one fifth pass into the Grande Grève fauna while one half of the species are present in the Helderbergian fauna of New York with suggestions of alliance in others. An Oriskany representation is also present in the fauna but it is rather slight and expressed by species which pass upward into the Grande Grève limestone.	4	8						

Cape Bon Ami beds

Logan's divisions 3, 4, 5, 6 (?)

This division of the Gaspé limestones embraces all that Logan included in his divisions beginning with no. 3 at the base and running to no. 6. It is not quite clear to us just how the division 6 is to be delimited on stratigraphic grounds but I may observe that the grass-green arenaceous lime-

stone which Logan refers to the upper part of his no. 7 is conspicuous at Shiphead, part way down the declivity to the coulée. This coulée at Shiphead, from the reading of Logan's description given above where he states that the summit beds of no. 6 slope down into a valley which divides the hills of the promontory into a double range, would appear to have been assumed as the dividing line between 6 and 7. This division line seems to us quite conventional and the lower beds of the Grande Grève formation with Chonetes canadensis and other characteristic species of this formation rise beyond the coulée eastward into the summit beds of the ridge forming Cape Gaspé. The Cape Bon Ami beds afford only vertical exposures in sheer cliffs facing the sea, their landward slopes being both heavily wooded and covered by overlying beds; hence we know but few fossils from them. Billings spoke of them as passage beds, yet they are fully 1000 feet thick and will sometime produce more complete evidence of the life of this period.

"The Quay," Cape Rosier cove

Fauna of the Cape Bon Ami beds

Logan's lists again cite species which are unknown to us from these beds and as these identifications have not been verified in Billings's later description of the fauna we can not safely take account of them. Thus Leptocoelia flabellites is cited from divisions 4 and 5 but no

mention is made of these horizons in Billings's final tale of species. In these preliminary lists the following were given:

Pterygotus	Leptocoelia flabellites
Phacops	L. concava
Orthoceras	Strophomena rhomboidalis
Conularia	Chonetes
Lucina	Discina
Spirifer crispatus	Lingula

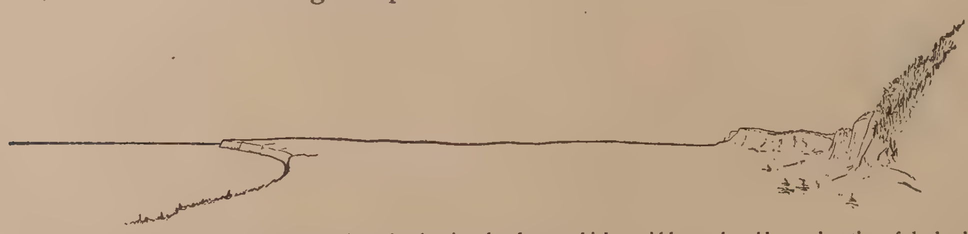
So far as our observations extend, the fauna is as follows:

Cordania gasepiou *nov.*	Orbiculoidea bella (*Billings*)
Poleumita princessa (*Billings*)	Lingula artemis *Billings*
Platyceras *cf.* unguiforme *Hall*	L. lucretia *Billings*
Kionoceras *cf.* rhysum *nov.*	Duncanella *cf.* rudis *Girty*
Modiomorpha varia (*Billings*)	Hindia fibrosa (*Roemer*)
Leptaena rhomboidalis (*Wilckens*)	

These species have largely been derived from the Quay, an extension of the cliff which borders Cape Rosier cove and they are for the most part diminutive forms. The little and feeble assemblage is in marked contrast to the outburst of species in the formation above.

Cape Bon Ami; elevation 700 feet

Hindia fibrosa is in the fauna at Dalhousie, N. B., subsequently considered. Duncanella rudis, Leptaena rhomboidalis, Platyceras unguiforme are species of the Helderbergian, and Cordania gasepiou is in the Grande Grève fauna.



The same view with the cliffs much reduced in scale, showing the change which would be produced by an elevation of the land to the 50 fathom line. Distance from Cape Bon Ami to the old shore line, 8 miles

Grande Grève limestones

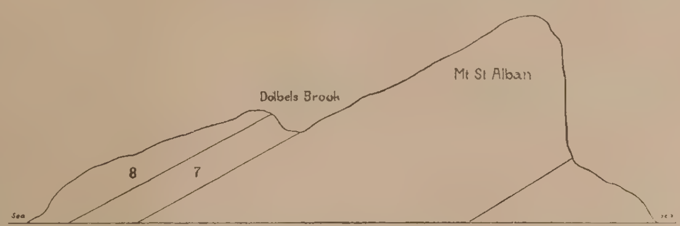
This series of strata is divisible as follows in descending order:

3 Pure gray blue limestones without chert

2 Impure gray limestones with chert

1 Drab hydraulic limestones with pure, heavy-bedded limestones above.

1 We conceive the lowest beds of this series to be represented by drab and yellowish sandy hydraulic limestones in thin, irregular plates and carrying rare layers and nodules of chert. These beds are exposed along the bed of Dolbel brook at Grande Grève and at the bottom of the coulée at Shiphead. At the latter point they lie below the very characteristic green layers which Logan makes the summit beds of his division 7. In these hydraulic layers is the first well defined exemplification of the fauna of the Grande Grève series. Specially abundant is Chonetes canadensis, covering entire slabs of the rock; Leptostrophia irene and L. magnifica are also very common. The overlying purer limestones free from or with little chert carry Hipparionyx proximus, Rhipidomella musculosa, R. logani, Megalanteris thunei, Camarotoechia pliopleura, all in abundance and affording a very striking combination. With them is the remarkable trilobite Gaspelichas grandegrevensis. For the most part these beds are buried under the higher strata and it is only along Dolbel brook that exposures are well shown above the dolomitic layers beneath.



Section across the Forillon at Grande Grève and the Kings road to Cape Rosier cove. Elevation of Mt St Alban 1170 feet

On the shore at Lehuquet's cove east of the Grande Grève these purer limestones appear in force, attaining a thickness of 50 feet. Here they present the chocolate brown color characteristic of some of the purer layers

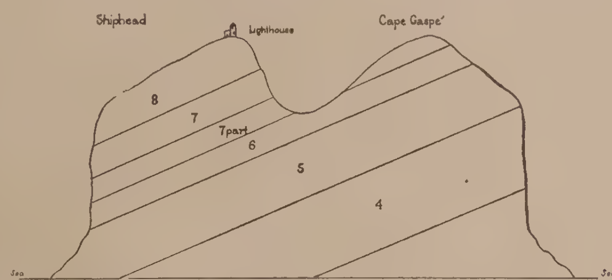
of the Onondaga limestone of New York and in their lithic and stratic features are very suggestive of that rock. At this locality fossils are profuse, especially Rensselaeria ovoides var. gaspensis, Camarotoechia pliopleura, Proetus phocion, Phacops logani. The combined thickness of the two parts of this division is about 100 feet.

Sketch of Shiphead from the coulée separating it from Cape Gaspé

2 The chert-bearing, impure limestones constitute most of the exposures to be found on the south slope of the Forillon and may be studied wherever the soil is thin. So abundant is the chert that by differential weathering it has been left standing out on all exposed surfaces, the rock presenting an altogether similar aspect to the cherty layers of the Onondaga limestone. The rock has been permeated by silicious matter to such a degree that it passes into "rotten stone" after extraction of the lime. Excellent outcrops of these layers are seen at the foot of the King's road and up this road over the slopes to the west. Stripping of the soil in the hunt for silver-lead veins in recent years has exposed the strata at several spots along the highway below and above Grande Grève. Fossils do not abound in all layers, but they are extremely abundant in some and these are the chief repository of the fauna of the formation. Eatonia peculiaris constitutes entire layers, Spirifer cyclopterus, S. plicatus, S. murchisoni, Dalmanites dolbeli, D. esnoufi, Lichas bellamicus, Conularia lata, are characteristic and abundant species. Hipparionyx proximus, Rhipidomella musculosa, R. logani, Megalanteris thunei and Chonetes canadensis, the index species of the lowest beds, have not been observed at this horizon.

It is not easy to estimate the thickness of these beds. I should

include with them the grass-green shale of Shiphead, with Dalmanites dolbeli at the top of Logan's division 7 and from the base of these to the base of the chert beds on Shiphead is about 300 feet. Above are 75 to 100 feet of chert-bearing rocks on which the lighthouse stands, making an approximate total of 400 feet. The beds of our division 3, if ever present at the cape, have been sheared away.



Section across the Forillon at end of Cape Gaspé; St Lawrence river at the north (right), Gaspé bay at the south. Elevation 690 feet. The figures represent Logan's divisions, of which 8, 7 and perhaps part of 6 are embraced within the Grande Grève limestones

3 The beds of this division are gray-blue limestones, free of chert, and are exposed along the shore at Little Gaspé where they are overlain by the Gaspé sandstones. They contain pretty much the same fauna as the beds immediately beneath, though Chonetes melonicus has, in a single instance only, been met with at any other horizon. Logan has regarded the contact of limestone and sandstone at Little Gaspé an unconformity and in this case these beds may not represent the true summit of the series as they are absent from Grande Grève to Shiphead, but it is quite likely that their absence is due to shearing away. They are apparently about 50 feet thick.

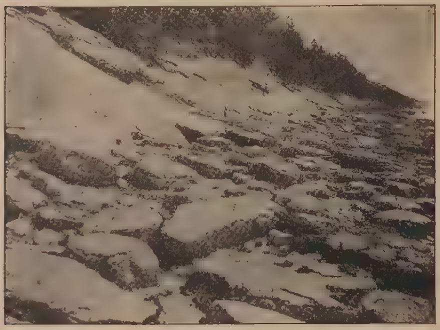
Our estimate of the probable thickness of these strata, 550 feet, falls notably below that of Logan, 800 feet, but in our judgment some portion of the series has been lost at the top and it is quite possible that the original thickness fully equaled that ascribed to it by Logan.

Dip. The inclination of the limestones on the Forillon is practically uniform and the lower beds are conformable herein with the upper. The degree and direction of dip was given by Logan as southwest < 24°. This dip is qualified by local displacements of slight extent along joint faces entering the cliffs at large angles to the strike and along these lines are veins of calcite and barite mingled with a fault breccia and carrying

small quantities of galena. For nearly 250 years these little silver-lead deposits have been periodically exploited and more money has been expended on them than has been or can ever be taken out. The veins may be seen at Little Gaspé, at Grande Grève, St George's cove, Indian cove and elsewhere.

The general southward slope of the hills of the Forillon from the high crests on the north coast is almost an expression of the true dip, deviating therefrom as the original surface contours have been modified by wear. The hillside slopes are steep but are for the most part less than 24°.

The dip of the Grande Grève limestones, south shore of Forillon near Little Gaspé



The dip of the Grande Grève limestones along the south shore of the Forillon from Little Gaspé west

The succession of the strata as expressed on the Forillon is continued inland to the upper reaches of the Dartmouth river but there is no place where the series can be found displayed to such advantage as in the original and typical section. At Peninsula opposite Gaspé Basin, by following the brook there transecting the strip of sandstones in the foreland one encounters behind them the chert-bearing limestones. This section, however, does not extend far into the limestone deposits.

Fauna of the Grande Grève limestones

It is quite noticeable that the species of this fauna are of restricted upward range. Future study may demonstrate a more refined subdivision of the rock series on the basis of such range of the species.

VERTICAL DISTRIBUTION OF SPECIES

	Divisions 1	2	3
Annelids			
Cornulites cingulatus *Hall*	....	x	
Autodetus beecheri *Clarke*	....	x	
Tentaculites elongatus *Hall*	..	x	
Spirorbis latissimus *nov*	...	x	
Serpulites	...	x	
Trilobites			
Phacops logani *Hall* gaspensis *nov*	x	x	
Dalmanites micrurus (*Green*)	x		
D. emarginatus *Hall*	...	x	
D. dolbeli *nov*	....	x	
D. lowi *nov*	...	x	
D. veiti *nov*	....	x	
D. vatinius *nov*	....	x	
D. gaveyi *nov*	....	x	
D. phacoptyx *Hall and Clarke*	...	x	
Probolium esnoufi *nov*	....	x	
Proetus phocion *Billings*	x	x	
Cordania becraftensis *Clarke*	....	x	
C. gasepiou *nov*	x		
Lichas bellamicus *nov*	....	x	
Gaspelichas forillonia *nov*	x	x	
Ceratocephala robinia *nov*	....	x	
Entomostraca			
Beyrichia kloedeni McCoy *cf.* acadica *Jones*	....	x	
Bythocypris *sp. nov*	....	x	
Aparchites *sp*	....	x	
Cephalopods			
Kionoceras rhysum *nov*	....	x	
K. champlaini *nov*	...	x	
Orthoceras	....	x	
Cyrtoceras	....	x	
Pteropods			
Hyolithus richardi *nov*	....	x	
H. oxys *nov*	....	x	
Conularia penouili *nov*	....	?	
C. *cf.* desiderata *Hall*	....	x	
C. lata *Hall mut*	....	x	

VERTICAL DISTRIBUTION OF SPECIES (*continued*)

	DIVISIONS		
	1	2	3
Gastropods			
Platyceras *cf.* fornicatum *Hall*	....	x	
P. leboutillieri *nov.*	....	x	
P. *cf.* nodosum *Conrad*	....	x	
P. paxillifer *nov*	...	x	
P. tortuosum *Hall*	....	x	
P. lejeunii *nov*	...	x	
P. (Orthonychia) belli *nov*	...	x	
P.	...	x	
Holopea *cf.* antiqua (*Vanuxem*)	.	x	
Coelidium hebe (*Billings*)	...	x	
C. egregium (*Billings*)	...	?	
Eotomaria voltumna (*Billings*)	...	x	
E. lydia (*Billings*)	...	x	
E. delia (*Billings*)	...	x	
E. ? rotula *nov*	....	x	
Bellerophon plenus *Billings*	....	x	
B. (Plectonotus ?) gaspensis *nov*	....	x	
Diaphorostoma affine (*Billings*)	....	x	
D. desmatum *Clarke*	x	x	
D.	...	x	
Strophostylus expansus *Hall*	...	x	
Pelecypods			
Actinopteria communis (*Hall*)	...	x	
A. textilis (*Hall*)	....	x	
Aviculopecten ? incrassatus *nov*	....	x	
Pterinopecten proteus *Clarke mut*	....	x	
Megambonia crenistriata *Clarke*	....	x	
Mytilarca canadensis *Billings*	....	x	
M. nitida *Billings*	....	x	
Cypricardinia distincta *Billings*	....	x	x
Palaeopinna flabellum *Hall*	...	x	
Modiomorpha varia (*Billings*)	....	x	
Leptodomus canadensis *Billings*	....	x	
Goniophora mediocris *Billings*	....	x	
G. tethys (*Billings*)	....	x	
Conocardium cuneus (*Conrad*)	....	x	
Schizodus ventricosus *Billings*	....	x	
Nuculites	....	x	
Brachiopods			
Glossina acer *nov*	x		
Lingula elliptica *nov*	x		
L. rectilatera *Hall*	...	....	x
Orbiculoidea montis *nov*	x		
O.	x		

VERTICAL DISTRIBUTION OF SPECIES (*continued*)

	DIVISIONS		
	1	2	3
Pholidops terminalis *Hall*	....	x	
P. *cf.* ovata *Hall*	....	x	
Craniella ? grandegrevensis *nov*	....	x	
Crania pulchella *H. & C.*	....	x	
Chonetes canadensis *Billings*	x		
C. melonicus *Billings*	....	....	x
C. antiopa *Billings*	x		
C. billingsi *nov.*	x	x	
C.	....	x	
Chonostrophia complanata *Hall*	x	....	x
Anoplia nucleata *Hall*	....	x	
Dalmanella lucia (*Billings*)	....	x	
Rhipidomella logani *nov.*	....	x	
R. musculosa *Hall*	x		
R. lehuquetiana *nov.*	...	x	
R.	....	x	
Schizophoria ? amii *nov*	....	x	
Hipparionyx proximus *Vanuxem*	x		
Orthothetes woolworthanus *Hall* gaspensis *nov*	x	x	
O. becraftensis *Clarke*	x	x	
Gaspesia aurelia (*Billings*)	....	x	
Stropheodonta parva *Hall* avita *nov.*	....	x	
S. crebristriata (*Conrad*) simplex *nov.*	....	x	
S. patersoni *Hall* precedens *nov.*	....	x	x
S. galatea (*Billings*)	....	x	
S. hunti *nov*	....	x	
S. lincklaeni *Hall*	....	x	
S. magniventer *Hall*	....	x	
Brachyprion majus *Clarke*	....	x	
Leptostrophia magnifica *Hall*	x		
L. irene (*Billings*)	....	x	
L. oriskania *Clarke*	x	x	
Strophonella continens *nov.*	....	x	
S. continens equiplicata *nov.*	....	x	
S. continens senilis *nov.*	....	x	
S. continens equalis *nov*	....	x	
S. ampla *Hall*	....	x	
Leptaena rhomboidalis (*Wilckens*)	....	x	x
Spirifer arenosus *Conrad*	x	x	
S. arenosus unicus *Hall*	....	x	
S. murchisoni *Castelnau*	....	x	
S. cyclopterus *Hall*	....	x	
S. fimbriatus (*Conrad*)	....	..	
S. plicatus (*Weller*)	....	x	
S. raricosta (*Conrad*)	....	x	
S. modestus *Hall* nitidulus *nov*	....	x	
S. *sp.*	....	x	

VERTICAL DISTRIBUTION OF SPECIES (*continued*)

	DIVISION		
	1	2	3
Cyrtina rostrata *Hall*	....	x	
Meristella champlaini *nov*	....	x	
M. lata *Hall*	....	x	
Rhynchospira	....	x	
Nucleospira *cf.* ventricosa *Hall*	....	x	
Leptocoelia flabellites (*Conrad*)	....	x	
Coelospira concava *Hall*	....	x	
Camarotoechia dryope (*Billings*)	....	x	
C. excellens (*Billings*)	....	x	
C. *cf.* ramsayi *Hall*	....	x	
Plethorhyncha barrandii *Hall*	....	x	
P. pliopleura (*Conrad*)	x		
Uncinulus mutabilis *Hall*	....	x	
Eatonia peculiaris (*Conrad*)	....	x	x
Beachia amplexa *nov*	x	x	
Megalanteris thunii *nov*	....	x	
Rensselaeria ovoides (*Eaton*) gaspensis *nov*	x	x	x
R. sp. ?	....	x	
Cryptonella ? ellsi *nov*	....	x	
C. ? fausta *Clarke*	....	x	
Centronella glansfagea *Hall*	....	x	
Bryozoans			
Fenestella *cf.* lata *Hall*	....	x	
Polypora ? psyche *Billings*	...	x	
Stictopora	....	x	
Corals			
Zaphrentis incondita *Billings*	....	x	
Phillipsastraea verneuili *Billings*	....	x	
Favosites helderbergiae *Hall*	...	x	
F. *sp.*	...	x	
Pleurodictyum lenticulare (*Hall*) laurentinum *nov*	....	x	
Monticulipora	...	x	
Striatopora *cf.* issa *Hall*	...	x	
Graptolites			
Dictyonema *cf.* splendens *Billings*	....	x	
Chaunograptus gracilis *nov*	x		
Sponges			
Hexactinellida	....	x	
Receptaculites jonesi *Billings*			
Total 154			

GEOLOGY OF PERCÉ

Away from the Forillon where the limestones are displayed in typical development, there is a divergence in expression which can be best set forth by a description of the geologic structure of the region about Percé where they and their associated strata are most readily accessible and most forcibly presented.

Percé lies facing the Gulf of St Lawrence fifteen miles due south of the Cape Gaspé light. It is a spot of extraordinary and dramatic beauty of situation. Exposed to the full potency of the sea few places display with more compelling effect than this broken and deeply gnawed coast, the tremendous destructive power of the ocean. The ribs of the Forillon are mighty but the limestones of Percé and its towering and isolated Pierced rock surpass them in startling picturesqueness. The traveler approaching this spot from the south in a westering sun, guided from afar by the towering red cross-crowned summit of Mt Ste Anne, hugging the shore cliffs of Cape d'Espoir and Cape Blanc, sees nothing of the spectacle in store for him till as his boat beats round those headlands the stupendous rock bursts on his amazed view, towering in majesty and clothed in a garb of many colors, while the ragged limestones of the Murailles stretching away to the north turn to him their verdure-clad slopes. Let him come upon the Percé harbor from the north and as he rounds St Peter and steams across the Malbay the Percé rock fixes his eye and in ever growing majesty subtends a larger and still larger angle of his sight; at his right are the higher and brilliant cliffs of the Murailles leading their assault upon the sky in ragged lines. But perhaps none of these approaches by water is excelled for effectiveness by the view which greets the traveler on the way leading over the high Percé mountain from the Barachois of Malbay. Here, as, through truly Alpine scenery, one reaches the hight of grade, the isolated rock strikes the eye, head on, like a gigantic ocean liner rounding the point of Mt Joli and sailing into the port of the North beach.

The settlement here is one of the oldest in America. Even before Jacques Cartier on a hot July day in 1534 sweltered in the Bay of Chaleurs, recording his experience in its name, and planted the cross and flowers-de-luce of France on the sand bar at Douglastown up Gaspé bay, fisherpeople from the shores of Brittany and the Bay of Biscay had begun their operations under the overshadowing protection of the Rocher Percé, from which the place has taken name[1] and which for near 400 years has drawn the amazed wonder of every passing traveler. The beaches to the north and south of the rock afforded a base of operations for the fishing, and were thronged during the season with hundreds of fishermen long before Henry Hudson had wet keel in the waters of New York.

Percé rock may be prosaically described as an isolated mass of almost vertical limestone strata lying at the angle between the north and south beaches. Through a channel 200 yards wide roll the waters which twice each day at flood tide cut it off from the lesser hights of the mainland. It is 288 feet high at the prow or landward end, 215 feet high over its single arch and 154 feet high at its outer end. It is 1420 feet long; at its outer end stands an obelisk, the remnant of a fallen arch and it is 1565 feet from prow to the outer end of this pillar. It is about 300 feet in width at its widest parts but varies much in its diameter. There is a narrow beach on both sides for a part of the distance at low water, but it is an uncertain thing disappearing at high water except in retreats on the north shore and at no time can one now make the circuit of the rock by foot.

The singular beauty of this amazing scenic feature is partly due to its unusual symmetry, but more to its brilliancy of color. Percé rock is no such gray pile as one may find among the striking sea ruins of the northern oceans, on the shores of Caithness at Thurso and Scrabster in Scotland, in Hoy and about Stromness in the Orkneys, and even the brighter shades in the rock piles of the Magdalen islands farther out in the gulf do not make

[1] In many writings, specially those of early date, the entire region is spoken of as l'Ile Percée, the name of the island having been transferred to the mainland. Only a remnant of the name remains; Percé is the place of the Pierced rock.

Base from Crown Lands map

Geology by J. M Clarke

Geological Map of Percé, Gaspé

a comparison adequate. Its walls are bathed in tints of purple-red, bright yellow and gray-blue, the natural shades of the limestone, and these are diversified by great streaks of white calcite which vein the mass. On its top the green carpet of grass spreads downward as the slope permits while over the jagged anfractuosities near the summit, a deep orange-red lichen has added its color to the scheme. The top of the cliff is the home of countless gulls and cormorants ever moving about it like a halo of fog scuds and screaming sempiternally in the same shrill notes that echoed on the sea cliffs of the lost mountain in the ages past.

Seeking for some clew to the rate at which the sea has been devouring Percé rock, I have looked for other evidence than can be found in the cliff itself. It is not strange that so marked a feature of the coast should have made a profound impression on the earliest explorers and here and there are references to it in the writings of some of them who had found the Isle Percée a haven for wood and water, and occasionally a note in the relations of the Recollet and Jesuit fathers. In Champlain's *Des Sauvages* of 1603,[1] I find this account of it but there is nothing in it that does not fit the conditions of today. "The Isle Percée," he says, "appears to be a very high rock sheer on both sides; between these is an arch through which shallops and boats can pass at high water. At ebb tide one can walk from the mainland to the island, it being only four or five hundred steps."

The great explorer and founder of Canada was not then seeing the rock as it stands today. This is evident on reading the later accounts. The single arch he describes may be that now represented by the passage seaward between the rock and the obelisk but it is clear that the single arch of today was not then in existence.

In 1672 Nicholas Denys, seigneur of Percé, "Gouverneur Lieutenant General pour le Roy, et Proprietaire de toutes les Terres et Isles qui sont depuis le Cap de Campseaux, jusques au Cap des Roziers," wrote:

[1] Des Sauvages ou Voyage de Samuel Champlain de Brouage fait en la france Nouvelle l'an mil six cent trois. Ch. 1.

The Isle is a great rock which may be 50 to 60 fathoms in sheer hight straight up from the foot of the two sides and has a width of 3 or 4 fathoms; at low water one can go from the mainland by foot all round it; it may have a length of 350 or 400 fathoms; it has been much longer, reaching even to the Island of Bonneaventure but the sea has devoured it at the foot so that it has fallen and I have seen it when it had only one passage in the form of an arcade, through which a barge can pass at full sail. It is this which has given it the name of the Isle Percée. There have two others formed since, which are not so large but are growing all the time. It appears that these passages weaken its foundation and will be the cause of its eventual destruction after which the sailors will no longer be able to work here. All of them that come here to fish cast anchor on the lee of this island, at a length of two cables off; one has here 3 or 4 fathoms of water, further off is a constantly increasing depth.

Père Sixte La Tac, who had visited the coast probably on his way to and from his mission in Newfoundland in 1689, spoke of the rock as having but a single arch.

Faucher St Maurice, in his charming and cleverly padded sketches of a short trip along this coast (1877) records having seen in the possession of Admiral Inglefield on board H. M. S. Bellerophon a copy of an engraving made in 1760 which represented the rock with three arches through it. It has been my good fortune to obtain a copy of this old copper plate, which is reproduced here in reduced scale. Its date was the year after the fall of Quebec and curiosity was doubtless keen enough in England over so remarkable a feature of her new conquest to justify the execution of this expensive plate. It was drawn by Captain Henry Smith on the SPOT and the same pride that led the skippers of the 1700's to have their ships painted on Sunderland and Liverpool jugs, led him to put his frigate in the foreground of the picture. The rock is here viewed from the north with Mt Joli at the right and Bonaventure island at the left. Its arches are two in number, not three; and though the rear arch has now fallen it is noteworthy that the chief projections on the side of the rock are essentially the same today as they were 145 years ago. The distant view beyond the rock shows the busy fishing fleet off the lower beach.

A View of the Pierced Island, a remarkable Rock in the Gulf of St. Laurence, Two Leagues to the Southward of Gaspee Bay.

Vue de l'Isle Percée, Rocher remarquable dans le Golfe St. Laurent a 2 Lieues au Sud de la Baye de Gaspé.

Drawn on the SPOT by Capt. Hervey Smyth. Engraved by P. Canot.

London publish'd according to Act of Parliament 1760, by Thos. Jefferys, the Corner of St. Martins Lane.

Reduced from the original copperplate

Father Chrêstien LeClercq, who was stationed at Percé for 12 years from 1675 and again for a number of years after, interrupting his mission by a voyage to France, gave this description of the rock, upon the accuracy of which we may rely, for it had been for all this time the most conspicuous object within his vision: "It," he says, referring to Gaspé bay, "is only Seven Leagues from the Isle Percée which is not, as some imagine, an island capable of lodging inhabitants; because it is only a rough Rock steep on all sides, of an extraordinary hight and a surprising abruptness. It is so pierced by three or four distinct passageways that the barges pass full manned and at full sail through the largest of these openings. It is from this fact that it derives the name of l'Isle Percée, although it is really only a peninsula or a Presqu 'isle, of which one can easily make the circuit afoot when the sea is low; and resembles an island only at high water. It is separated from terra firma by only two or three acres [*arpent* = 180 feet] of ground. It would seem as if it had formerly been joined thereto and that it had been cut off by the storms and tempests of the ocean."[1]

The discrepancy in these accounts may arise from some disagreement between the dates of observation and of publication, but they can be reconciled to this conclusion that the arches had during the period of Denys's observation grown from one to three or four and probably one of these had soon thereafter fallen in.

I find no other descriptive account of the rock throughout the whole of the 18th century and up to the time when the Abbé Ferland wrote of his missionary visitation along this coast in 1836. Ferland's stay at Percé was brief, not of more than two or three days duration, and much of the material of his entertaining narrative was derived from other than original sources. Of the rock he says:[2]

The Isle Percée appears to have been formerly joined to Mt Joli; it is separated therefrom only by a straight channel which is dry at low water. The length of the plateau is about eight acres and its width is reckoned at only from 60 to 80 feet. In its entire extent the rock is only a continuous cliff, the average hight of which is 290 feet. The waves have already cut out two arches remarkable for their regularity. The open passages in the rock are about 25 feet wide, 20 feet in hight and 30 in length. Through the

[1] Nouvelle Relation de la Gaspésie. 1691. p. 4, 5.

[2] La Gaspesie.

principal arch the barges can pass at all times either under sail or by oars; through the other they can only float when the sea is high. The debris of the rock scattered all along bears witness that the sea is continuing its encroachments. Some day, perhaps, the arches will fall in and the Isle Percée will form three immense columns which will rival in volume the pyramids of Egypt.

Sir William Logan was at Percé in 1843 on his first field work as director of the Canadian Geological Survey. While at the village he put up with a Mr Moriarty and in the fragments of his journal which have been published by Professor Harrington[1] he says that his host formerly cut hay on the top of the rock but had abandoned his farming there some six years before, as a foolhardy fellow by the name of Pierre L'Aigle took it into his head to dance on a projecting piece of rock which gave way, dashing him to death on the beach. Today the angles of the rock are such that to climb it seems beyond human daring.

On the 17th of June, 1845, one of the two arches fell. My informant, Mr Philip Le Boutillier, an engaging and vigorous man of above 80 years, says that as he was on that day turning the key in the door of the Le Boutillier Co.'s shop, he was startled by a thunderous and ear-splitting crash and turning toward the rock saw, amid clouds of dust and spray and the terrified screams of the birds, that the outer and greater arch had fallen. And thus today it stands with but one of the three or four arches on which the eyes of Denys and LeClercq so often looked, remaining, and a new one creeping at right angles to the rest, lengthwise through the base of the seaward obelisk. Here we behold, as under the eye, the ruin which the sea has wrought on this single isolated rock in the last 250 years. I find on carefully comparing my measurements with the dimensions which can be derived from the Crown land maps of Percé, the original draft of which is not far from 50 years old, that there is no apparent change of dimension in this interval except in a lessening diameter at certain points.

It is not often that a geologist falls upon a proposition so concrete and uncomplicated as that which an isolated mass like Percé rock presents.

[1] Life of Sir William Logan. Montreal. 1883.

A simple combination of two causes has contributed to the destruction of this mass, the sea and the frost. The destruction has gone on by leaps and bounds in the falling of arches carrying down thousands of tons of rock at a time, though the times were distant intervals. But the steady work of the less destructive agents never ceases. From Nicholas Denys's statement in 1672, that on his first trip to Percé there was only one arch in the rock, as Champlain saw it in 1603 but when he returned some years later he observed two others, and that subsequently in his day one of the latter broke down, it is evident that the progress of destruction then went on at a rapid pace compared with its advance during the last century. But these arches have all been at the thin outer edge of the cliff which easily became honeycombed. This thinner part of the rock is now nearly gone and the waters have a more serious problem before them. A thing of singular beauty indeed the long rock with its three or four arches, in the days of the 1600's, must have been. Today its proportions are more stable, for the single perforation lies under one of the highest parts. Though its rearward obelisk is giving way and is perforated at its base the splendid mass itself is not perceptibly thinning to destruction.


L'isle Percée, 1675

Let us look a little to its future.

We have given above the dimensions of the rock. That part of it exposed to the action of sea and frost has a volume of about 6,000,000 tons. From the broken vertical strata the fragments fall easily under the winter's storms but they are wedged in tight and in all my wanderings at the foot of the cliff I have observed only an occasional rain of small fragments. However the base of the cliff is covered with large blocks and the shores of Mt Joli made up of its fragments. There are projecting angles of the rock where blocks lie in piles of 10–20 pieces weighing from 5–10 tons each but these are the accumulations of no one seems to know how many years. The amount of annual fall of rock would be little more than a probable guess and any average would be broken by the occasional fall of an arch. This latter factor is however now practically eliminated. After careful questioning of the residents and observation of all the conditions I should regard 300 tons per annum a fair average of fall, 500 tons large and 1000 tons highly improbable. With the first approximation it will take sea and weather upward of 20,000 years to accomplish the ruin of the little island, with the second 12,000 and with the third 6000

years. Unborn generations of Gaspesians will gaze upon the undimmed luster of this magnificent cliff.

The late Prof. James Hall, in one of his volumes of the *Paleontology of New York*, under the happy title of "Dry Dredging," gave the numerical results of collecting species of Helderbergian fossils from a certain field in the Helderberg where the soil was largely residual and frequently turned over. The figures were startling illustrations of the abundance of certain organisms on the old sea bottoms. Though the fossils of Percé rock are arranged in layers with relatively barren intervals yet it would not be possible to work over one average ton of the rock without finding multitudes of remains of specimens of the trilobite Dalmanites biardi, or hundreds of individuals of the brachiopods Chonetes canadensis and Spirifer plicatus and other species according to their fertility. Let us reduce these suggestions to absurdly low terms.

Dalmanites biardi
10 per ton - - - 60,000,000 individuals in Percé rock
Chonetes canadensis
100 per ton - - 600,000,000 "
Spirifer plicatus
100 per ton - - - 600,000,000 "
Leptostrophia magnifica tullia
100 per ton - - 600,000,000 "
Chonetes antiopa
50 per ton - - - 300,000,000 "

There are thousands of millions of organic remains in the little section of ancient sea bottom represented by Percé rock.

If one needed proof that the sea has always been the *alma nutrix* of life, here it is, not to be surpassed by the daily scenes which have been enacted along the Gaspé coast for more than two hundred and fifty years in the codfishing. Millions of cod are yearly taken from these waters but the cod fails not. If all these millions of all these years were taken together they would not equal in number the remains of the animals now lying imbedded in the Percé rock.

Turning landward the eye rests first on Mt Joli, a low truncated rock cone connected at low tide with the Pierced rock by a sand bar, thence extending southward and separated by a short beach from another small headland, Cape Canon, sometimes Battery point, all a rock escarpment of vertical strata not more than 100 feet high at any point. To the south of Cape Canon opens the broad Robin fishing beach, which reaches away to the nearly horizontal outcrops of red conglomerate at the opening of Len-

PERCÉ ROCK
Painted by Frederick James

festy's brook and beyond to the headland which bounds the South cove, two miles away, Cape Blanc or Whitehead, another vertical mass of limestones over the edges of which the red strata of the Bonaventure conglomerate have been laid flat. To the north of Mt Joli and the beach of the North cove, begin the Murailles, the high rocky sea wall which fronts the Malbay, rising with a deeply notched sky line in grassy and deeply furrowed slopes and falling off sheer to the water's edge; the tattered remains of a mountain which stretched away into Malbay but has yielded its better part to the restless tooth of the sea. The effect on the landscape of this ragged escarpment is very striking but its impressiveness is appreciated best only from the sea, from which its rocky front is alone approachable. At the north end of the North cove the escarpment rises abruptly in the calcareous and arenaceous shales of Cape Barré; thence northward framing the angular recesses beaten out by the sea, the cliff becomes even higher till the line reaches Red peak at the north and falls off abruptly into the gorge of the Grande Coupe. Except for Cape Barré these rocks are brilliantly tinted with reds and yellows and, we shall presently observe, were a part of the tinted strata comprising the Percé rock, though here the angle of their slope is greatly altered and nearly conforms to the slopes of the mountain surface.

East face of Mt Joli

All these bold contours are brought closely together so that in the

radius of a mile from the courthouse we embrace the Murailles, cliffs of Joli, Canon, the Percé rock, the broad intervales of the coves and the low south escarpments of the horizontal conglomerate. And behind them all, as a background to the picture, rises Mt Ste Anne, its lofty perpendicular precipices on the eastern face rising to a hight of about 1200 feet. The majestic beauties of this cluster of summits known as Percé Mountain can be appreciated only by penetrating to the midst of their bold bluffs and deep canyons. In these recesses hidden away from the traveler along the coast, the artist's brush becomes as impotent as a camera among the Alps. On the slopes of the easternmost member of this cluster pious ardor has cleared a broad way to the shrine at the top, whence the eye travels without obstruction to Anse du Cap (Cape Cove) and Grande Rivière southward, and northward to Point St Peter across Malbay, and to Shiphead and the shores of Grande Grève across Gaspé bay; inland over the rolling timbered wilderness of the folded interior, and seaward beyond the Percé rock to the island of Bonaventure, three miles away. This mountain is the summit of the great cap of Bonaventure conglomerate which lies over and against the erect limestones of Percé, Mt Joli, Cape Canon and Cape Blanc, extends downward to the sea at the Robin beach and makes the Percé reef, and continues beneath the water to Bonaventure island where only this rock is found.

Vertical strata on north face of Mt Joli; the Murailles in the distance

From the slopes of Mt Ste Anne flow the little drainage ways of the

The headland of Percé from the summit of Mt Ste Anne. Devono-Carbonic conglomerates in the foreground. Siluric shales and limestones on the shore (Mt Joli and Cape Canon), Devonic limestones in Percé Rock

region, the coulée or Barré brook to the North beach, Robin brook to the South beach and Lenfesty's brook directly through the rising escarpment of the Bonaventure rocks to the south.

The general geologic structure presented at Percé is simple in broader features but is very greatly complicated by a breaking down of primary structures. Percé rock and the cliffs which line the shores between the North and South beaches are exemplifications of the original southermost fold of the Devonic series which seems to have formed the southern limb of the geosyncline indicated by Dr Ells. In this series all outcrops stand at the same angle though separated by beach intervals which are in some measure the sites of fault displacements. The attitude of the strata is almost vertical with a dip of 80°–85° to the south and the continuity of this angle from Percé rock, the highest member of the series, to the beds of Cape Canon is not changed except for minor contortions of the strata in the lower members of the series.

Of this series all the members except the Percé rock are of Siluric age, and we shall briefly consider them in their actual order as massives and their apparent order in the geologic succession from the base up.

The wall between the beaches

SILURIC — **Cape Canon massive**. This is a series of calcareous and black argillaceous shales considerably disturbed internally by slight folds and undulations, thrusts of slight measure which have produced glistening shear faces, veined in all directions, richly jointed and cleaved, but in spite of all these features the vertical attitude of the mass is still apparent with the slight general inclination toward the south. Irrespective of its undulations it has a sea front of 630 feet and this is an approximate measure of its actual thickness. After repeated search it has revealed no fossils.

On the summit of Cape Canon the well grassed rock surface slopes deeply landward, then abruptly rises at a distance of about 400 feet from the edge of the cliff and the strata stand upright again in a bare dome of

rock at which is a now abandoned limekiln. The rock here was burned by Mr Philip Le Boutillier and from him I learn that the burning has been only partly successful but at times a purer limestone has been brought to the kiln from the outcrops at Cape Blanc, two miles south.

The Limekiln massive

The rocks at this limekiln are an undoubted part of those at Cape Canon though the beds are heavier limestones much seamed with calcite veinules, largely a limestone conglomerate. They have a thickness of 200 feet. A single bed of a similar conglomerate was observed infolded in the schists of Cape Canon.

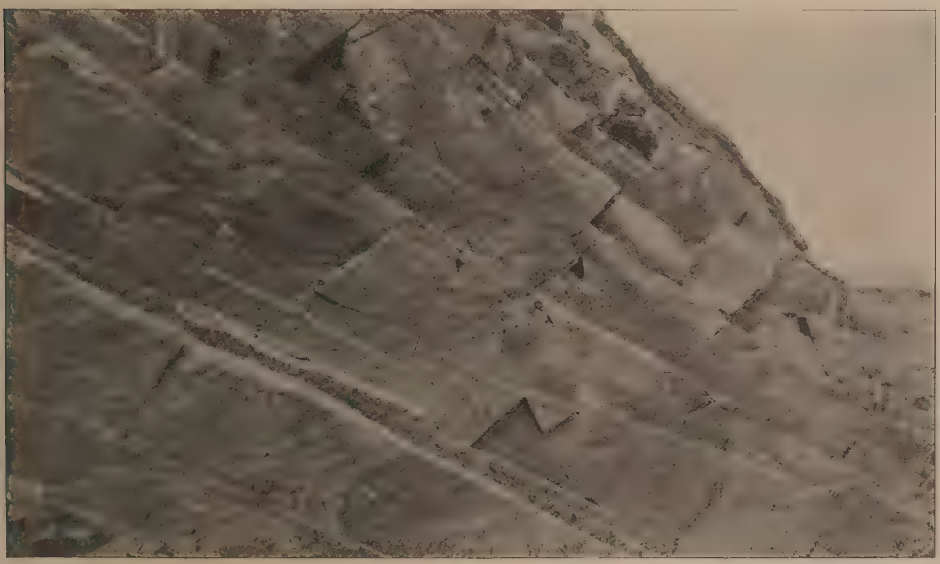
Just beneath these conglomerates on the south slope are even bedded impure gray limestones and from detached blocks here fossils have been obtained. There is some reason in regarding these fossil-bearing blocks as not pertaining to this spot though concerning this point I would not venture to be unqualified in my statement. These fossils are:

Plectambonites sericeus (*Sowerby*) (very common)
Rafinesquina, a geniculated species
Leptaena rhomboidalis (*Wilckens*)
Protozyga exigua *Hall*
Ambonychia *sp.*
Ceraurus pleurexanthemus *Green*

Though few in number, the species abound in individuals and the assemblage clearly indicates a late stage of the Lower Siluric equivalent to middle or upper Trenton age.

Mt Joli massive. North of Cape Canon is a beach interval of 350 feet. The grass-grown bank of the beach shows a red soil cap and in it here and there are blocks of red conglomerate as though deposition of the conglomerates was over a rough bottom wherein this clay-banked beach was a deeply gullied line of disturbance.

The erect strata of gray thin limestones and calcareous shales which constitute the low headland at Mt Joli begin, not at the scarp itself, but at low water may be seen extending well out from the shore. Along the



Vertical, jointed and ripple-marked Siluric limestones. South flank of Mt Joli

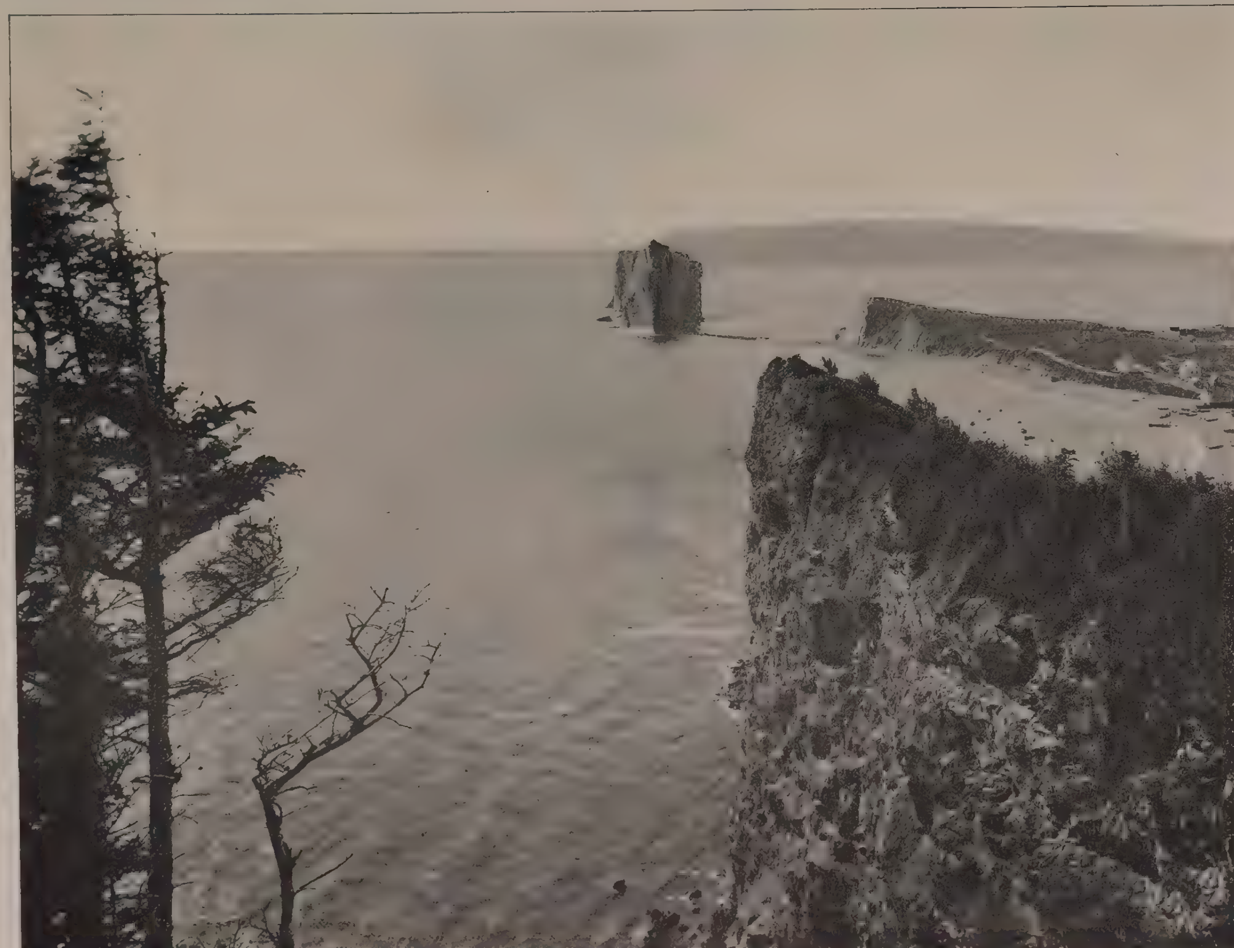
North beach these outlying strata form little reefs, but the intervals between them and the wall of the promontory are concealed by the beach. Taking the Mt Joli massive as a whole, it has an approximate length along the east sea front of 700 feet, the highest point being at the north, the upper slope declining southerly, ending rather abruptly at the beach separating it from Cape Canon. There is little change in the lithic composition of the strata composing Mt Joli, but there is definite evidence of displacement in the mass itself. For the greater part of the length of the sea wall the

strata are essentially vertical with slight undulations; but at a distance of about 250 feet from the south end of the cliff the strata become much more irregular, maintaining their nearly vertical attitude but are folded and slightly displaced among themselves and faulted against the more erect strata of the main part of the mountain. The southern part of the mass is composed of strata similar to those of the northern but increasingly slaty in composition. In both parts of this Mt Joli massive fossils were found, but they are by no means of common occurrence; moreover they are so wedged into the vertical strata that their extraction is not easily accomplished.

South flank. In the layers of the south flank of the mountain which strike n. 30° w., are essentially vertical but with many undulations and irregular inclinations toward the south, and are thin, fairly pure limestone strata from two to five inches in thickness separated by sandy shale masses, these species have been found:

Hindia fibrosa (*Roemer*)?
Subretepora
Dalmanella testudinaria (*Dalman*)
Rafinesquina *sp.*
Strophomena *sp.* strongly geniculate form (very common)
Parastrophia hemiplicata *Hall* small form
Zygospira *cf.* uphami *Winchell & Schuchert*
Ortonia *sp.*
Ampyx hastatus *Ruedemann*
Tretaspis reticulatus *Ruedemann* (very common)
Calymmene callicephala *Green*
Pterygometopus *cf.* intermedius (*Walcott*)
Ptychopyge ulrichi *Clarke* (common)
Illaenus americanus *Billings*

This very striking though small array of species is emphatically indicative of early Siluric age, we may say in a general sense equivalent to the Trenton, but can not escape the inference that it is early Trenton with suggestions of Pretrenton age. The trilobites are specially noteworthy, for Ampyx hastatus and Tretaspis reticulatus have been found



View from the summit of the sea wall or Murailles, Percé. The limestone cliffs in the foreground attain a hight of 600-700 feet over the waters of Malbay. Percé Rock and Mt Joli in the middle distance connected by the batture exposed only at low tide. Bonaventure island in the background

before only in the lower Trenton conglomerate of Rysedorph hill near Albany and definitely indicate not the Trenton fauna normal to the Mississippian province of that time, but the invading fauna from the Atlantic province whose closer affiliations are with European species.

Two spots in the sea wall have afforded these fossils, one not far from the south end of the cliff where were taken

Calymmene callicephala	Parastrophia hemiplicata
Dalmanella testudinaria	Zygospira
Rafinesquina	

These were from calcareous nodules imbedded in the shales.

The other locality lies just north of the most apparent line of displacement where the strata have lost their contortions. Here were obtained

Tretaspis reticulatus	Illaenus americanus
Ampyx hastatus	Pterygometopus *cf.* intermedius
Ptychopyge ulrichi	

It is not safe to infer great difference in age of these associations.

North flank. From the calcareous layers which, with the eroded interleaved shales form the outermost northern reach of the strata and are exposed only at low tide as reefs, were obtained a few fossils; Platyceras, large species of Helderberg type; Zaphrentis corticata Billings; Z. cingulosa Billings.

The shaly layers on the high vertical north face of the scarp have afforded species suggesting the following identifications:

Hindia *sp*	Leptaena rhomboidalis *Wilckens*
Monograptus *cf.* clintonensis *Hall*	Stropheodonta *cf.* varistriata *Conrad*
Duncanella *cf.* borealis *Nicholson*	Spirifer *cf.* niagarensis *Conrad*
Streptelasma *cf.* caliculus *Hall*	Spirifer modestus *Hall?*
Pleurodictyum *cf.* lenticulare *Hall*	Cypricardinia *aff.* sublamellosa *Hall*
Dalmanella *cf.* perelegans *Hall*	Phacops *sp.*

Giving special attention to the trilobite in which lies the clearest indication of geologic age, we find it to be a fully developed Phacops such as nowhere occurs in the typical Siluric deposits of the Mississippian sea or

Appalachian gulf. Its glabella is large, rotund and coarsely pustulose, the glabellar furrows obsolete, eyes large and the genal angles have minute spinules. The pygidium is broad, the axis having six to eight well defined rings, the first bearing a prominent tubercle, the pleurae having five to six ribs all grooved and separated by deep furrows. These structural points indicate an early period in the history of the genus, hence if Siluric, a final stage.

The construction of this assemblage as a whole as indicative of a very late Upper Siluric marine fauna is justified and we would therefore put together the entire mass of the strata 550 to 600 feet thick, as appertaining to this horizon, that is the series of limestones and shales extending from the reefs bordering the north flank of Mt Joli, southward almost to the first palpable shear zone.

Devonic — **Percé massive.** The attitude of Percé rock and of the shore strata just described indicates a slight overturn of all. The older strata uniformly lean up against those of younger age and we shall presently note that this attitude implies that we are here dealing with strata which are the northern limb of a heavy slightly overturned anticline.

Significance of its colors. The colors of the rock which are so striking to the eye both in themselves and by contrast with the gray shore cliffs, are dark purple-reds and light or gray yellows. The distribution of these tints is in large measure in alternating or successive solid masses, but there is besides this coloration an interesting modification into successive minor bands of red along lines and cracks affording passage for bleaching waters. The mass is coarsely veined with calcite and finely fractured and displaced but these internal disturbances have not materially affected the continuity or the attitude of the strata. The lesser color bands running in various directions concentric to water passages are evidently of secondary origin displaying the gradual reduction of the red iron oxid by the organic acids in the percolating waters. The red bands are the residual and unbleached remainder of the original solid color.

Faulted pebble of Percé limestone

The brilliant red colors of the Bonaventure conglomerate and the sandstones which lie over the broken limestone folds of the region and give color to the soil, do not at this point concern us. Their significance as evidence of deposition of the sands in shallow waters is confirmed by all collateral evidence from stratigraphy, geography and fossils. But it is of immediate importance to know if such colors in the limestones point to similar conditions. We may therefore make reference to recent publications upon this theme by Spring [1] and Moberg.[2]

The former of these writers has considered the subject from the purely chemical and empirical standpoint. The latter has treated it on the basis of paleontologic and bathymetric evidence. The conclusions of both are in essential harmony.

The red oxids coloring limestone strata are evidence of deposition of the sediments in waters sufficiently shallow and near enough to the coast to be subject to the effects of the organic acids brought down to them by terrestrial drainage. The effect is facilitated and in notable measure conditioned by ready oxidation, involving the conception of occasional exposure as calcareous mud flats to the direct action of the atmosphere. Katzer,[3] who has also closely studied these phenomena, suggests exposure to sunlight as an active agency in the effect produced.

These conclusions, arrived at from such different points of view, are of profound concern and compel us to revise the commonly accepted notion of the bathymetric conditions of limestone deposition. When prevented from exposure to air and light or far enough distant from the coast to be out of reach of terrestrial acids, the color oxids do not form. Thus a highly colored limestone may be stratigraphically continuous with one of neutral

[1] Spring, W. Ueber die eisenhaltigen Farbstoffe sedimentärer Erdboden und ueber den wahrscheinlichen Ursprung der rothen Felsen: Neues Jahrb. für Mineral. 1899. 1:47.

[2] Moberg, J. C. Om rödfärgade lager inom Sveriges Kambro-silur: Geol. Fören. i Stockholm Förh. 1904. 26:134.

[3] Ueber die rothe Farbe von Schichten-gesteinen. Neues Jahrb. für Mineral. 1899. 1:177.

shade out of the immediate reach of terrestrial drainage and which during deposition escaped such coastal movements as would bring it near the surface of the waters. It is needless to add that the deposition of such fine calcareous muds in tidal flats must have been on protected coves and embayments. Because, then, the limestones of the Percé massive are so highly tinted while none of the great series in the Forillon carries such colors, we have no reason herein for regarding the two as not continuous; on the contrary internal evidence demonstrates their effective continuity while that just cited would indicate that the Percé strata were deposited in the shallow bays of an ever uneasy coast line.[1]

Venation in the limestones of Perce rock

The nature of the fossils in these limestones does not exclude the conception of continuous deposition in shallows, but these organic remains occur in distinct and rather widely separated bands which in themselves may indicate the maximum depression and imply a slow but constant vertical oscillation in the area of deposit through no great amplitude.

[1] In another place (N. Y. State Mus. Mem. 6, p. 200) we have brought together the evidence which indicates that black shale deposits are depositions in very deep water, quite the reverse of the current view which has held them to be deposition from quiet shallows. We are called upon to revise and invert prevalent ideas of the bathymetry of the limestones and bituminous shales and I am disposed to believe that no very substantial antagonism to the later conceptions will be presented by paleontology.

PERCÉ ROCK

The Arch, looking south; Cape Blanc in the distance

While fossils are abundant, the number of species is not great in comparison with the fauna of the Grande Grève limestones on the Forillon.

In the following table we give the list of the species.

Annelids

Tentaculites leclercquia *nov.*
T. elongatus *Hall*

Trilobites

Phacops logani *Hall*
Dalmanites perceensis *nov.*
Probolium biardi *nov.*
Ceratocephala robinia *nov.*
Proetus phocion *Billings*

Pteropods

Conularia desiderata *Hall* tuzoi *nov.*

Gastropods

Platyceras leboutillieri *nov.*
P. tortuosum *Hall*
P. guesnini *nov.*
P. *sp.*
Trochonema lescarboti *nov.*
Diaphorostoma perceense *nov.*

Lamellibranchs

Aviculopecten jumeaui *nov.*
Actinopteria communis (*Hall*)?
Megambonia denysia *nov.*

Brachiopods

Lingula elliptica *nov.*
L. spathata *Hall*
L. rectilatera *Hall*
Orbiculoidea schucherti *nov.*
Pholidops *cf.* ovata *Hall*
P. terminalis *Hall*
Craniella (?) grandegrevensis *nov.*
Chonostrophia complanata *Hall*
Chonetes canadensis *Billings*
C. antiopa *Billings*
Hipparionyx proximus *Vanuxem*
Stropheodonta lincklaeni *Hall*
S. magniventer *Hall*
Leptostrophia magnifica tullia (*Billings*)
L. tardifi *nov.*
Leptaena rhomboidalis (*Wilckens*)
Spirifer arenosus *Conrad*
S. cyclopterus (*Hall*) *Billings*
S. murchisoni *Castelnau*
S. plicatus (*Weller*)
Cyrtina rostrata *Hall*
Meristella lata *Hall*
Leptocoelia flabellites (*Conrad*)
Megalanteris thunei *nov.*
Beachia amplexa *nov.*
Rensselaeria ovoides (*Eaton*) gaspensis *nov.*

Corals

Pleurodictyum lenticulare (*Hall*) laurentinum *nov.*

This is clearly the Grande Grève fauna but the 43 species here listed are in notable numerical contrast to the 150 of the Forillon limestones. There are other differences in the faunal combinations. Thus the following species are common to both regions:

Phacops logani (*var.*)
Proetus phocion
Ceratocephala robinia
Tentaculites elongatus
Conularia *cf.* desiderata
Platyceras tortuosum
Diaphorostoma (perceense, affine)
Actinopteria communis?
Lingula elliptica
L. rectilatera

Orbiculoidea schucherti
Pholidops *cf.* ovata
P. terminalis
Craniella (?) grandegrevensis
Chonetes canadensis
C. antiopa
Hipparionyx proximus
Stropheodonta lincklaeni
S. magniventer
Leptostrophia magnifica (tullia)
Leptaena rhomboidalis
Spirifer arenosus
S. cyclopterus
S. murchisoni
S. plicatus
Cyrtina rostrata
Meristella lata
Leptocoelia flabellites
Megalanteris plicata
Beachia amplexa
Rensselaeria ovoides gaspensis

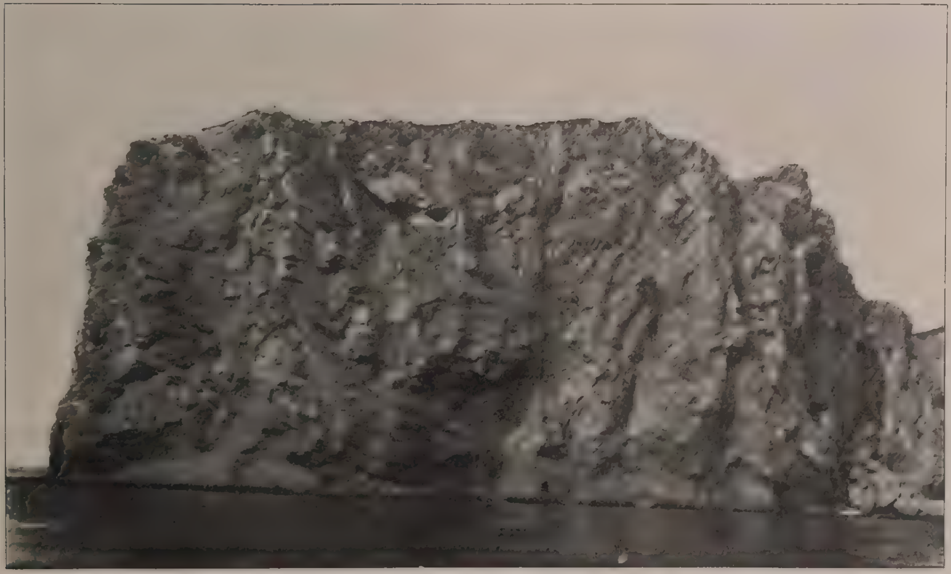
Thirty-one in all, a very large proportion of the Percé fauna itself but a small one of the entire Grande Grève fauna. There are some noteworthy differences in development at the two places. Thus, the most frequent species at Percé common to both localities, may be stated in order of abundance

Chonetes canadensis
Spirifer plicatus
Leptocoelia flabellites
Leptostrophia magnifica (tullia)
Spirifer arenosus
Chonetes antiopa

All of these are relatively rare on the Forillon. Eatonia is absent at Percé and Proetus phocion, common at Grande Grève, is rare here. Among the most abundant of all the species of the Percé rock is the trilobite Probolium biardi, not known on the Forillon.

The Percé massive thus represents some part of the Grande Grève series as is evident from its fauna, but there is no evidence that it is any part of the limestones now presented on the Forillon nor does it appear from the fauna what position the massive holds with reference to the Grande Grève series. The peculiar colors of the Percé strata are entirely wanting on the rocks of the Forillon but these are as we have suggested a secondary effect due to exposure. The Percé massive unlike the Forillon limestones presents none of the lithic characters so peculiarly suggestive of the Onondaga beds of New York, the chert beds and the chocolate limestones. There is an absence from the fauna of any species that suggest this later age, e. g., Stropheodonta patersoni precedens, S. parva avita, S. crebristriata simplex, Strophonella continens

Percé. The Murailles and North beach, from the south. Cape Barré at the right



Percé. The sea face of Cape Barré, from Malbay

and ampla, Spirifer raricosta. If anything, the fauna has a truer expression of earlier age, or at least its early expression is less complicated with later suggestions.

The Murailles

North of the North beach is a high escarpment facing Malbay, whose rocks rise to a vertical hight from the water of 600 feet, and reach their boldest expression in the Red peak, where they drop off abruptly to the Grande Coupe, an evident fault displacement.

The strata of these Murailles stand at a wholly different angle from those we have been describing and they have been palpably downthrown from an original continuity with the latter.

Cape Barré beds. The southernmost point of this sea cliff is Cape Barré which shelters the beach. The strata here are thin, sandy, blue gray limestones with intercalated shale, the rock becoming reddish at the top beneath the soil cap. They dip northeast 30° to 40°, which is an angle not reproduced in any of the strata elsewhere exposed, and their attitude toward the Percé strata farther north leads to the inference that these rocks are normally subjacent to the latter and have been separated therefrom by the downthrow of the superjacent mass. These Cape Barré beds, so far as exposed, may attain a thickness of 75 to 100 feet. Their relations with the strata at Mt Joli are determinable from no structural relation exhibited, for they are separated from the latter by the long interval of the North beach. These beds contain fossils, but very sparsely; a few Lingulas and an Ambocoelia-like brachiopod probably allied to Spirifer modestus Hall, which is a Helderberg species, also a small corrugated Leptostrophia like L. oriskania Clarke, and a Conularia closely comparable to the species we have identified as C. lata from Grande Grève; but the age and position of the beds are decisively indicated by the presence of a species of the trilobite Dicranurus.

This fossil is of more than ordinary interest. The genus Dicranurus has been described heretofore only from two geologic formations, the Helberberg (New Scotland beds and Coeymans limestone) of eastern New

York (D. hamatus Conrad) and from the equivalent horizon Etage G, of Bohemia (D. monstrosus Barrande *sp.*). The species from Cape Barré (D. limenarcha) is represented only by an incomplete cephalon but it is rarely that any other part of the genus has been observed in any of its occurrences. It was a species larger than the New York form and perhaps even larger than the Bohemian. Its elongate, subconate middle lobe is well delimited by a deep nuchal furrow, the lateral lobes are separated by a shallow transverse or oblique groove, while the axial diameter of the occipital ring from the base of the central lobe to the fork of the spine is relatively less than in D. hamatus. The free cheeks were attached to this specimen, but they have not been preserved except along the sutures. The great neck spines are highly divergent and very heavy. Barrande gave the angle of divergence in D. monstrosus as 60°, in D. hamatus it is 45°, in D. limenarcha it is 80°, measured from the central occipital tubercle as apex, axially for one third of the length of the spines. These spines are curved outward, downward and back, and probably made a deep recurvature as in the other species, though they are not preserved at the tips. On their proximal extent is a low median depression. The surface of the head is covered with acute pustules scattered sparsely with very much finer ones between. On the occipital ring the central pustule, which is more conspicuous than the rest, as in other species, is punctuated at the top by a circle of depressions. The head had an original length to the point of recurvature of the neck spines of about 40 mm, the greatest divergence of the spines is 29 mm, the axial length to the angle of the spines, 23 mm, of which 9 mm belong to the occipital ring; width between the eyes, 25 mm.

Dicranurus limenarcha

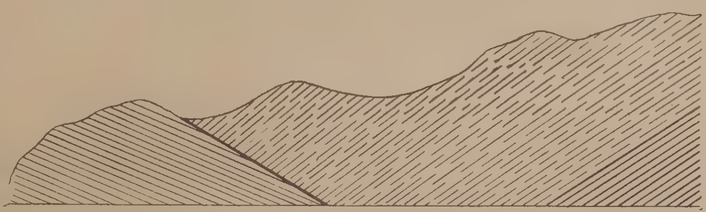
From no other evidence have we so satisfactory a basis for the conclusion that the Cape Barré beds follow close below the beds of Percé rock and above those of Mt Joli. We may therefore conclude that either these strata lie buried in the tide-swept interval between the Percé rock and the outermost vertical strata belonging to the Mt Joli massive, or that, originally in place here, they have been pushed out by faulting. The space between these two massives not in the line of the connecting sand spit but rather

Percé. The sea face of the Murailles, at the Blowhole. The fault plane between the Percé Rock strata at the west and the Cape Barré massive is shown in the middle left of the picture

Percé. The sea face of the Murailles, westward from the Blowhole

in the line of vertical thickness of the strata, at right angles to their present position, is barely enough to admit the beds of Cape Barré. Doubtless they have been largely squeezed out in faulting and pitched over on their side where they now lie, though some part of them may remain in the interval, to be exposed by some favoring neap tide to the eye of the trained observer.

Percé strata of the Murailles and Barré brook. Rounding Cape Barré where the dip of the gray limestone and shales is to the north, beyond the first point toward the Blowhole, a sea cavern gnawed out by the waves, the tinted Percé strata again appear, but here lying at a steep angle, 20° to 40° to the southeast and abutting palpably against the thrust plane of a fault which is well marked in the face of the cliff, sloping obliquely downward and to the north. The line of displacement is well enforced by the contrast in color between the downthrown yellow and red strata and the somber grays of the Cape Barré massive. Logan noted the fact that these downthrown strata were of equivalent age and probably a part of the Percé rock, and Ells cites the occurrence in the rocks at the Blowhole of the fossils Spirifer arenosus and S. cyclopterus (probably S. murchisoni); we have also found



Section at Blowhole. Cape Barré beds at left, downthrown Percé beds at right

Dalmanites percéensis	Leptocoelia flabellites
Phacops logani	Leptostrophia irene
Acidaspis *sp.*	Chonetes antiopa
Megalanteris thunei	Spirifer arenosus
Chonetes canadensis	S. murchisoni

and a few others, but the specimens are not very well preserved nor are they in any wise so abundant as at Percé rock.

These Percé beds about the Blowhole are probably again downthrown in themselves in their further extension along the Murailles but without

essential change of dip, for this same southward dip is well apparent as far as the coulée or Barré brook where Percé fossils were also found. The latter seem to be the summit beds of the limestones and from them the following species were obtained :

Spirifer arenosus	Megalanteris thunei
S. murchisoni	Leptostrophia irene
Chonetes canadensis	Coelospira
C. antiopa	

The beds are gray and red, nodular on weathering, but normally a limestone conglomerate whose fragments are derived from the Percé strata. The outcrop is in the strike and the beds apparently rise uniformly into the Murailles. A displacement is evident along the bed of the brook but its amount was not estimated. Red peak, which is the highest and easternmost of the Murailles, is capped by beds of this rock apparently conformable in dip to those below. The displacement of the tinted Percé strata (the term being here used as indicative of the horizon of the Percé rock), against the Cape Barré beds is evident on the south road leading up the mountain side to the Grande Coupe, as well as in the coulée. In the great sea front of Red peak, the high face rising 660 feet over the water is believed to bring up the lower gray limestones in conformity and, though these beds are difficult of access, it is likely that here are the strata which fill the broken interval between the Percé beds and those beneath, the rocks of Cape Barré and perhaps also in part those of Cape Blanc. Logan and Ells speak of the appearance further along the shore of Malbay of a dark shale with Ampyx and other fossils (not specifically determined) and hard by a thin limestone with Halysites.

Cape Blanc

Cape Blanc massive. The succession of the limestones and shales of the great Percé anticline is presented under a twofold aspect. One of these we have described. It is that best displayed and most clearly comprehensible. The other is seen in the promontory of Cape Blanc or Whitehead.

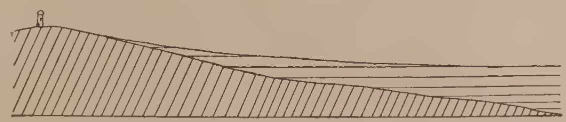
From Cape Canon southward for a distance of two miles sweeps

THE MURAILLES

Percé

Painted by Frederick James

the broad Robin fishing beach or South cove buttressed at the south by horizontal or slightly dipping beds of red sandstone and conglomerates rising into a constantly more elevated sea wall till Cape Blanc is reached. Here as one turns the point of the headland and rounds the light, vertical limestone strata are once more exposed and their contrast in color to the horizontal or slightly northeast dipping red strata which overlie them and abut against their slopes, gives name to the place. The sea wall is sheer and the foot of the cliff accessible with risk, even by water.



Shore section at Cape Blanc. Horizontal Bonaventure conglomerates resting on nearly vertical Siluric limestones

The vertical thickness of these rocks measuring from the point of the cape southward is estimated at 700 to 1000 feet. They are light gray in general effect and the succession of the strata is obscurely presented in the highway and field outcrops. With the slight inclination of the strata away from the vertical toward the south as seen in the Mt Joli massive, we first find in the highway cut ascending the cliff from the north, a red limestone, suggesting in tint the Percé rock. On the sea front these red beds are conspicuously shown forming the northern part of the exposure where overlain by the nearly horizontal beds of Bonaventure conglomerate. These beds carry

Favosites *cf.* hisingeri *E. & H.*	Trochonema
Halysites catenularius *Linné* typicus	Bellerophon
Zaphrentis *cf.* stokesi *E. & H.*	Lichas (fragment)
Lyellia affinis *Billings*	Trematopora (very slender branches)
Ortonia	Callopora
Anodontopsis	Small Whitfieldella-like brachiopods

but principally and oftenest a large and heavy shelled pelecypod having a broad cardinal plate extending inward from the hinge line, not attached to the bottom of the valves nor thickened at its junction with the hinge. This rock is of such character that it breaks in almost any direction except along the surface of these fossils; but one example of this species has the valves together and this, sectioned vertically, shows these projecting plates

not in apposition as though connected with the articulation of the valves, but standing apart with a well defined space between, indicating that they are a broad chondrophore. Further material will be necessary to elucidate the nature of this shell. It is clear however, from the list given, even though generic determinations only seem safe at present, that this congeries represents a stage of late Siluric, clearly older than the fauna of the Percé rock, probably older than beds of Cape Barré but not necessarily older than the north flank of the Mt Joli massive. These beds, the highest in the series, lie lowest in position as the entire mass is slightly overturned.

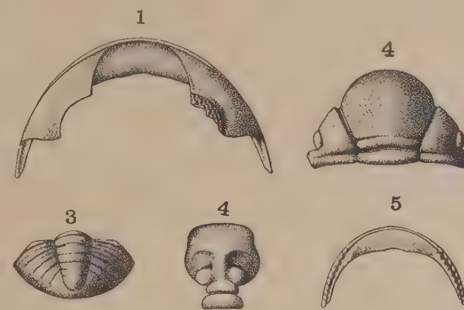
Beyond the light, seaward of the road, on the edges of the escarpment in the field whence the purer layers of limestone have been removed for burning, and which appertain to the southernmost and presumably lowest part of the series here represented, after careful search fossils were found, not in the blue and more abundant limestone, but in thin clinking limestone plates.

The mode of preservation here is singularly favorable though the material is not abundant, the fossils being weathered out on the surfaces of the plates and doubtless the fauna will prove an interesting and instructive one under more favorable opportunities for exploration. These slabs have afforded:

Phacops primaevus *nov.*	Zygospira recurvirostra *Hall*
Calymmene senaria *Conrad*	Orthis ? merope *Billings*
Bumastus, small species	Bolboporites americanus *Billings ?*
Asaphus or Ptychopyge	Glyptocrinus ?
Ceraurus pleurexanthemus *Green*	Homocrinus ?
Holopea *cf.* arctica *Schuchert*	Climacograptus
Camarospira bisulcata (*Emmons*) ?	Hexactinellid spicules

This association presents species of early Trenton age; a quite different congeries than that we have reported from the lower rocks of Mt Joli but indicative of about the same geologic stage. Of special note here is the trilobite, Phacops primaevus, which can not fail to interest students of trilobite phylogeny.

Both cephalon and pygidium, which occur commonly in these slabs, present an almost mature development of the genus Phacops, such as we have heretofore expected to find only in rocks of Devonic age. The glabella when uncompressed is round and full without segmentation but when compressed the lobes and furrows appear and the glabella takes on the aspect of a Pterygometopus. The suture is high on the cheeks and the eyes relatively long but with low visual surface. The cheeks are without spines. On the under surface the doublure is grooved and crenulated as in the early Devonic species. The pygidium is very short, having no resemblance to the dalmanitiform plate of Pterygometopus, has a stout spindle which ends abruptly and carries 3–4 annulations while the pleurae carry 2–3 flat ribs each divided by a fine furrow. In a preliminary account of the geology of Percé[1] I noted that these structures indicate a close approach to Phacops logani and concluded that the species probably indicated a late stage of the Siluric. The additional material since acquired leaves little doubt of the Trenton age of these beds notwithstanding the apparently much later age of this trilobite as interpreted by previously recognized standards.



Phacops primaevus: 1 The extra-sutural part of the cephalon, 2 the cranidium, 3 pygidium, 4 a compressed glabella showing the Pterygometopus-like lateral lobes, 5 underside of doublure showing lateral crenulations. All figures enlarged

The Cape Blanc limestones thus appear, from the evidence before us, to represent essentially the same time interval as the Siluric series displayed on the shore from Cape Canon to the head of Mt Joli; furthermore, though these series differ in the lithic characters exposed, there is every reason to regard the former as a downthrown part of the south limb of the great Percé fold. This mass of limestones fronting the sea at Cape Blanc extends inward in a broad band through Irishtown and its eastern edge has been traced by the writer through the Percé mountain where it nearly abuts against the great fault front of the Bonaventure conglomerate known as the "Amphitheater." From here it bears off towards the south shore of Malbay and disappears at the south end of Corner of the Beach, not reach-

[1] Percé. A Sketch of its Geology. N. Y. State Paleontol. An. Rep't 1903. 1904. p. 163.

ing the shore at any point and leaving only a narrow strip of much disturbed conglomerates to constitute the southern sea wall of the bay. The westward extent of these limestones is not known and their outcrops in the mountains have not proved to be fossiliferous. Their relations to the adjoining strata however, indicate in some measure the very great dislocations which have affected this region.

Relations of limestone and shale masses about Percé. The thickness of the masses here discussed may be approximately stated as follows:

Percé beds, 250–300 feet at Percé rock but probably rising in Red peak to	500 feet
Lost interval between Percé rock and Mt Joli (Cape Barré beds)	100–200 feet
Mt Joli massive	700 feet
Cape Canon massive	630 feet
	1730–2030 feet

Thus there is a development of approximately 2000 feet of limestones and shales representing the geologic series from early Siluric (Chazy-Trenton) to well into the early Devonic. The Cape Blanc massive with a thickness of 700 to 1000 feet is probably to be regarded not as an addition to, but in greater part at least a repetition of a portion of the series. The rocks on the Murailles do not add to, but repeat the series in part, with the exception of the Cape Barré beds which are partially provided for in the rock interval between Mt Joli and the Percé rock. In order of succession from the top downward, we should from present evidence arrange the masses thus:

Percé beds Cape Barré beds	Devonic
Mt Joli (north flank) beds Mt Joli (south flank) beds Cape Canon beds	Siluric

Faults. With the foregoing succession we deduce a profound displacement between the Percé rock and the north face of Mt Joli by which the

beds of Cape Barré for a thickness of 100 or more feet were squeezed out, and their remnant overturned to their present place and attitude, one fourth mile away, and their dip reversed.

A displacement of somewhat similar proportions seems to separate the coast cliffs from the thinned edge of the Bonaventure conglomerates and its course is indicated by the swale running from behind Cape Canon to the North beach. The course of this fault is nearly north-south. On the Murailles we find the clearly defined line of displacement along which the Percé beds have slipped down over the Barré beds inverting their dip and this entire mass of Barré and Percé beds was evidently cut off from the Percé rock by the line of faulting just mentioned.

We find evidence of a minor fault near the middle of the sea cliff of Mt Joli and it seems probable that the massives of Joli and Canon are separated by similar faults which have helped to give origin to the beach between them. These lesser faults probably do not extend very far inland. An interesting local displacement in the Cape Blanc limestones is seen on the highway at the crossing of Hayes creek, just beneath the north face of the hill. Here the creek has made its way through limestone strata which are nearly horizontal, while 50 feet away they are seen to be normally inclined almost to the vertical and overlain by the Bonaventure conglomerate.

The relations of the limestones and shales here discussed to the overlying Bonaventure conglomerates will be referred to in a subsequent chapter.

On Mt Joli

THE GASPÉ SANDSTONES

To Sir William Logan we again turn for the fullest account of the extensive series of deposits which he embraced under this name. The greater part of Gaspé county has been regarded as covered by these beds folded into anticlines and synclines presumably conforming with the limestones beneath. We are not certain of any erosion interval between the two. The contact line at Little Gaspé cove is a practical conformity, its variation therefrom being nothing in excess of the slight beach angle of sands against a shore ; but the change is quite abrupt, the upper layer of the limestone only showing some sandy content.

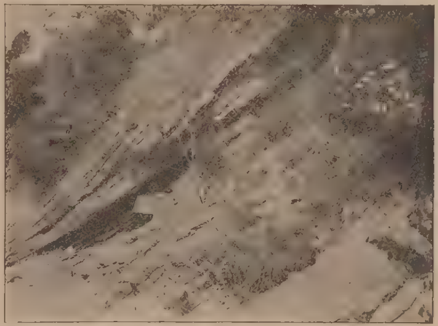
The interior of Gaspé county is a heavily wooded, tenantless domain, still a place of trails and portages, as little reduced to the pursuits and demands of civilization as the interior of Patagonia. But mountains of the same type as those further inland though of gentler expression are those which circle the Gaspé basin. Here, withdrawn from the fierce play of the gulf storms, the softer and rounder outlines prevail. The Northwest and Southwest arms, continuing into the Dartmouth and York rivers, run back along ancient depressions or troughs in the folded rocks. Gaspé village is at the axilla of these arms. If the traveler will let his rambles lead him around the crest of Cape O'Hara and down the raised sea beach below St. Albert's church he may observe the sandstone foundations of Gaspé mountain sloping at a steep angle toward the north and may follow them for a long distance up the Dartmouth river, to the volcanic dike at L'Anse au Cousins and beyond, always at this inclination. Across the Northwest

Contact of Grande Grève limestone and Gaspé sandstone at Little Gaspé

From Crown Lands map

Map of the village of Gaspé Basin at the junction of the York and Dartmouth rivers. This is a region of Gaspé sandstone except at the summit of the mountains in the northwest corner where the underlying limestones are exposed by erosion

arm above Peninsula he will find them sloping south, the two slopes meeting in a trough at the bottom of the bay. If he follow the shore southward from the inner docks among the Robin fishing stores and on toward Gaspé South or along the road on the other side of York he will note that the rocks dip in just the reverse direction to that at the Dartmouth, pitching downward to the south. The crest of the great fold of the strata passes right through Gaspé mountain not far away from Baker's hotel. As the hills rise behind this delightful little village "where," says the Abbé Ferland, "live the aristocrats of Gaspé," the bending of the strata brings the limestones which lie buried beneath the sandstones to the surface at the highest summits. One may follow the old portage trail from the clearing back of Baker's up through the woods over the first mountain but only the sandstones will appear. If he will take a more strenuous walk and climb the second mountain, separated from the first by the portage road running from L'Anse au Cousins to Gaspé South, he will find at the tops the limestones broken through the strata which lie over them. The hills of Gaspé Basin and the higher summits of the interior together constitute a great plateau undulated by distant folds.

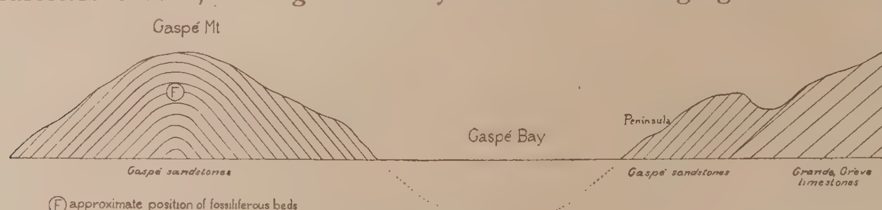


Contact of Grande Grève limestone and Gaspé sandstone; nearer view showing the cross-bedding of the sandstone layers

The scenery of the Basin is a restful contrast to that outside. Had the wasting forces which have worn off the summits of the hills gone farther down about the limestones they would have left more ragged crests behind them, but the softer sandstones have made only gentle curves. There is only a little room on the shores between water and mountain but from l'Anse au Cousins around to Gaspé South the slopes have been brought under cultivation and the spruce and fir driven upward. Not many sights are so inviting as the outlook from the hight of these clearings down the Bay, around through the narrow passage where the great bars of

Sandy Beach and the Peninsula nearly strangle the waterway, down along the hills of the Forillon to Cape Gaspé; and in the other direction the eye follows the shore line from Cape Ramsay along the course of the Basin which is bounded by a rising summit of like hills. The Basin is a harbor of such dimensions and absolute security that it is full of craft of many kinds, the schooners of the Robin fishing establishments, the luggers of coastwise trade, the cruisers of the cable inspection and fisheries service, the packet boats to Anticosti and the Labrador, now and then a pleasure yacht; and, when the sea is heavy outside, the fishing barges come scurrying in by scores.

From Gaspé eastward through Haldimand and Douglastown these sandstones extend, making low rocky shores but changing in color from



Approximate section of the Gaspé sandstones from Gaspé Basin across the northwest arm of Gaspé bay to the limestone hills

gray shades into red, and forming the red banks of the south shore of the Bay to Point St Peter. Here they face the Gulf and though still low the waters have played havoc with them. Included with them are the variously dipped limestone conglomerates and the play of the waves readily works these out into caverns and grottoes. At Point St Peter the waters have cut off little Plateau Island and honey-combed it with holes like the subterranean workings of a giant mole.

Little has been added to our knowledge of the stratigraphy of this vast deposit of sandstone since the date of the *Geology of Canada*. The great thickness assigned by Logan to the strata, 7036 feet, was assumed by Ells (1882) as a proper expression, but since the latter date Dr Ells has located certain presumable fault lines essentially parallel to the anticlinal axes, which are shown on the map here given, taken from his report on

petroleum products of these rocks. In a great thickness of such uniform and homogeneous sedimentation the positive location of faultings and more particularly the degree of displacement can be ascertained only with difficulty. We can not arrive at any conclusion as to the possible contraction of the estimated thickness of the strata because of these presumptive faultings and I therefore give here the section as stated by Logan in 1863.

The dip of the Gaspé sandstones at Peninsula

Succeeding the calcareous rocks just described, and resting upon them conformably, there occurs an important group of sandstones. The contact of the two series, as already stated, is seen at Little Gaspé; but between the visible base of the sandstone group and the place of its greatest development, there are two considerable undulations, and a probable dislocation of an uncertain amount. These render it difficult as yet to unite the whole series, with a certainty that no strata are repeated or left out. But though the section which shows the greatest unbroken series of strata does not reach to the base, it is probably not far removed from it; and it may therefore, for the present, be assumed, probably without much inaccuracy, to represent the whole group. In ascending order, the strata are as follows:

SHALES 1 Gray arenaceous and argillaceous shales, with beds of gray sandstone, varying in thickness from one to twenty feet, and one of them seventy-five feet. A three-inch band of argillaceous iron ore occurs about one hundred feet from the top. Towards the bottom, the beds weather of a rusty brown color, and contain abundance of plants. One of these, in its arrangement on the surface of the beds, resembles Fucoides graphica, but it may be the broken roots or stems of the other species of plants, which have been recognized in this deposit; surfaces thus characterized were met with in more than one locality. Many of the beds abound with the comminuted remains of carbonized plants, most of which are too obscure to be determined. Among them, however, are Prototaxites logani, Lepidodendron gaspianum, Psilophyton princeps, P. robustius, Selaginites formosus and Cordaites angustifolia; all described by Dr Dawson. Towards the lower part, there is a small seam of coal, with carbonaceous shale, measuring together about three inches; which appears to hold a regular course, having a bed of clay beneath, marked by what seem to be the roots of Psilophyton; while the stems and leaflets of the plant are met with in a thin seam of shale above the coal, and in the carbonaceous shale associated with it. On some of the leaflets, small shells of the genus Spirorbis are met with. More than 130 feet above the coal seam, there is a hard rough gray bed, looking like fire clay, with the fibrous impressions of Psilophyton roots penetrating it at right angles. Ripple mark occurs on some of the surfaces - - - - - - - 528 feet

FOSSIL PLANTS

COAL SEAM

SAND-STONES 2 Drab sandstones, many of them with a reddish tinge; they present spheroidal masses harder than the general character of the rock, and are marked by extensive ferruginous stains. A few scattered pebbles of quartz and jasper occur in some of the beds, which are in general thick, and separated from one another by layers and partings of gray argillaceous and arenaceous shale. IRON ORE Nodules of argillaceous iron ore are contained in some of the layers, and comminuted carbonized plants are frequently seen on the divisional surfaces; those which have been determined belong to the species already mentioned - - - - - - 916 feet

3 Drab sandstones, inclining to reddish at the bottom and greenish at the top; with occasional scattered quartz and jasper pebbles, and large spheroidal masses, as above. Ferruginous stains are frequent, and the beds, usually massive, are separated by layers of gray argillo-arenaceous shale, which, as well as the sandstones, sometimes contain nodules of argillaceous iron ore. In the middle and lower part, there are interstratified two conspicuous beds of claret-red, green, and dark gray argillo-arenaceous shale; in the upper one of which are two, and in the lower, eight bands of a gray tough rock, much like fire clay, penetrated vertically by the rootlets of Psilophyton - - - - - - - 428 feet

4 Drab sandstones, inclining to green; some of which contain quartz and jasper pebbles; many parts have large hard spheroidal masses, as before. The beds are in general very thick, and they are separated by layers of gray argillaceous shale, from which large argillaceous masses occasionally protrude into the superincumbent sandstone, some of these being as much as three feet high and as broad. Comminuted carbonized plants, similar to those already named, occur on the surfaces of the lower beds - - - - - - - - - - - - - 2052 feet

5 Drab sandstone, in massive beds, in only a few of which there are scattered quartz and jasper pebbles. The sandstones are interstratified with five conspicuous bands of claret-red, green and gray argillo-arenaceous shale, of an aggregate thickness of 140 feet - - - - - 442 feet

CON-GLOM-ERATES 6 Drab strong and coarse conglomerates, in massive beds, one of them 156 feet thick. The pebbles of these consist of white quartz, black chert, yellow, green, and blood-red jaspers, and jasper porphyry; with which are sometimes found others of feldspar and of limestone, the whole enclosed in a matrix of drab-colored sandstone. In some portions of the deposit, the pebbles diminish in quantity, so that the rock becomes a rather fine grained sandstone, with only occasional pebbles. The carbonized comminuted remains of plants occur on the surfaces of the beds, and in their oblique elementary layers or false bedding. Among the organic remains of this division, fish spines or ichthyodorulites occur, of the genera Onchus and Machaeracanthus; one of them, the M. sulcatus of Newberry - - - - - - - - - - 856 feet

RED SAND-STONES 7 Red sandstones, sometimes slightly calcareous, with green stripes and spots, many of the beds massive; associated with occasional drab sandstones, and with two thin bands of conglomerate, holding pebbles of quartz, jasper, and limestone. All of these are interstratified with red argillaceous and arenaceous shales, spotted and striped with green. In many cases, the sandstones exhibit on their under surfaces, highly relieved casts of shrinkage cracks and of raindrops, and on the upper surfaces ripple marks. The shales are sometimes penetrated by branching plants, in vertical, oblique, and prostrate attitudes; while one or two beds have fibrous rootlike impressions, probably of Psilophyton, running across them at right angles - - - - - - - - - - 1151 feet

L'Anse au Cousins on the Northwest arm, Gaspé Basin. A trap dike here cuts the Gaspé sandstones coming down to the shore in the foreground at the right

8 Drab massive sandstones, which in the lower part are clouded or mottled with a reddish tinge, and at the bottom exhibit an interstratification with red shales; at the summit the beds are inclined to gray. In many parts, they hold scattered pebbles of white and greenish quartz, and blood-red jasper, with some of limestone; but the pebbles never become so numerous as to constitute a conglomerate. On the surfaces of many of the strata, and in the oblique elementary layers or false bedding of some of them, there occur carbonized comminuted remains of plants; which are too imperfect to be determined - - - - 663 feet

7036 feet

LITTLE GASPÉ COVE The lower portions of this great series of sandstones are met with in Little Gaspé Cove; where in addition to the various species of fossil plants already mentioned, are found the remains of what appears to be a species of Calamites; one specimen of which shows a flattened stem 4 feet long, with a breadth of 4 inches. GASPÉ BAY The inferior portion of the formation skirts the northeastward side of Gaspé bay, and the northwest arm, from the cove, as far as the north branch of Dartmouth river; where it occupies a breadth of about 9000 feet, across the measures; giving, at an average dip of 26°, a thickness of about 4000 feet. On the southwest side of Gaspé bay, in the neighborhood of Gaspé basin, the same strata rise with an opposite and more precipitous slope, forming a trough under the bay. The thickness there exposed is again about 4000 feet. The same beds next fold over an anticlinal axis, which comes out upon the bay near Cape Haldimand; then, dipping at a very moderate angle on the southwest side of the axis, beneath the lagoon at the mouth of the river St John, they reappear, with a nearly opposite slope, at the southeastern end of Douglastown village; and exactly face Great Cape Oiseau (Cap Brulé of Bayfield's chart) and Little Gaspé on the northeast side of the bay. Following the coast, they exhibit a slight sinuosity in Seal cove TAR POINT (Bréhaut bay of Bayfield); and at the extremity of Tar point, between this cove and the next one farther on, they fold over another anticlinal axis; the position of which is indicated by a remarkable greenstone dyke, holding petroleum. The direction of both of these anticlinals is nearly northwest and southeast.

It is from this point to the termination of the series, in the cove immediately northward of Pointe Jaune or Yellow Head, that the strata given in the vertical section are found. The coast cuts them obliquely; and in every step southeastward from Tar point, higher strata are met with, in advancing, until Long cove is LONG COVE reached, where the red sandstones are seen. In this cove, the measures have a very moderate inclination, and a slight protrusion in the line of strike causes the coast section of the cliff to present a gentle arch in the center, repeating a part of the beds. Farther on, the section still gains upon the strata, in the vicinity of Red Head, and beyond it; until they are suddenly cut off by a fault, at the spot already indicated as the termination of the series. Throughout the whole distance, the strata are seldom concealed; and though several small faults occur, the allowance that is to be made for them, may be seen in the cliff, which is generally bold.

ANTICLINALS The two anticlinals which have been mentioned, appear to run parallel, as well to the mountain ranges of the neighborhood, as to the calcareous rocks on the northeast side of Gaspé bay. They may be about 3 miles asunder in a direct line. The northern one is traceable for 7 miles, from the vicinity of Cape Haldimand to the inner basin at Gaspé; which it crosses about 350 yards southwest of the Narrows at the entrance. It brings to the surface, on the north side of the basin, some beds of sandstone, which are rendered calcareous by an abundance of fossils.

These beds contain comminuted remains of land plants, and impressions that bear a strong resemblance to *Fucoides cauda-galli*. With these are associated, among other species, *Strophomena blainvilli*, *Rensselaeria ovoides*, two undetermined species of *Chonetes*, *Spirifera gaspensis*, *Leptocoelia flabellites*, *Avicula woodwardi*, and *Grammysia verneuili*. The beds to the northeast of these, along the southwest side of Gaspé harbor and bay, as already indicated, are upwards of 4000 feet higher in the series. They contain a few interrupted bands of a red color near the top, some of them with casts of shrinkage cracks; and along the strike, between Pointe Lourde and Cape Haldimand, some of the best characterized specimens of the land plants of the formation are to be obtained. In the upper 760 feet, eight beds are seen to be marked by the vertical rootlets of Psilophyton; and on one of these, 200 of the rootlets were counted in a square of 6 inches.

Sir William Dawson described the flora of these beds in detail.[1] With this we are not here specially concerned, but we may take note in passing that Dawson subdivided the series of Gaspé sandstones into three parts: a lower division embracing the beds at Little Gaspé and Gaspé Basin, coördinated with the Oriskany and Onondaga divisions; a middle division including the sandstones of Bois Brulé and Cape Oiseau (*aux Os*; on modern English maps *Ozo*) equivalent to the Hamilton group and an upper division represented by the outcrops of Long Cove and conceived to be the equivalent of the Chemung group. This is a somewhat arbitrary subdivision apparently based upon the distribution of the terrestrial flora found in the rocks and the author distinctly states his interpretation of the Gaspé sandstones as a whole as the equivalent of the entire Devonic system in its more westerly representation. Most of these plant remains were derived from near Tar Point on the south shore of Gaspé Bay and on the north shore from Little Gaspé west.

It is the marine fauna of these sandstones that chiefly interests us, best represented at or near the locality mentioned by Logan, which lies back of the first mountain at Gaspé Basin on the portage road crossing from the upper basin to l'Anse au Cousins on the Dartmouth river. In traversing this mountain along the old portage trail through the woods the direction of which is for the first part nearly at right angles to the portage road, one finds fossiliferous blocks all of a highly weathered cal-

[1] Fossil Plants of the Devonian and Upper Silurian of Canada, 1871, and pt 2, 1882; also Quarterly Journal Geological Society of London, v. 15, 1859, and 19, 1863.

Gaspé Basin from the north — York at the right, Sandy Beach in the middle distance. Gaspé Bay and the hills of the Forillon in the background

careous sandstone. Fossils are to be found in place also in the exposures under the highway just back of the Robin-Collas fish houses and loose all along the south shore of the basin from Cape Ramsay for a distance of 3 miles up the York river. Blocks of a compact quartzite carrying entire fronds of Fenestella and Cladopora, not observed at Gaspé mountain and with them Spirifer blainvillii, Rensselaeria ovoides gaspensis are found on the Northwest Arm, four or five miles above the Basin. From the hills in the rear of Gaspé village, presumably the localities which have supplied our material, Barlow collected species in 1883, listed as follows by Ells, (1884).

Psilophyton	Rensselaeria ovoides
Strophomena blainvillii	Spirifer gaspensis
Chonetes melonicus	Grammysia canadensis
[Chonetes canadensis]?	Tentaculites
Leptocoelia flabellites	Orthoceras

No other fossil-bearing localities readily accessible from the coast are known but in the upper reaches of the York river Logan found such calcareous bands with marine fossils at points which seem not to have been since visited for their fossil contents. He says:

At the mouth of the Patawegia brook, joining the York river on the left bank, about 3 miles above the lowest exposure of limestone, a 6 foot band of this kind occurs in a great thickness of crumbling arenaceous shale, also holding fossils. Among those which characterize the whole exposure are Zaphrentis, Orthis, Strophomena, Chonetes, Rensselaeria ovoides, Leptocoelia flabellites, Avicula, several species of Acephala of undetermined genera, Orthoceras and Dalmanites. Undetermined species of Spirifer and Cyrtodonta are common in similar strata on Silver brook; and loose fragments of calcareous sandstone, containing some of the above fossils, are found on the surface between the York and Douglastown rivers, south of the lowest exposure of limestone.

These localities are 20–25 miles in from Gaspé Basin. The position of the calcareous sandstones appears to be near the bottom of the entire series. This inference is largely deduced from the attitude of the strata containing them in Gaspé mountain, for this mountain is a truncated anti-

cline with steep limbs, the strata sloping sharply to the north on the Dartmouth river side and to the south on the York river side. The lower beds would be exposed near the middle of the mountain and such is the position of the fossiliferous beds which Logan thinks to be 4000 feet below the upper or outer beds of the anticline.

Fauna of the Gaspé sandstone

	1 Grande Grève	2 Gaspé sandstone	3 Helderbergian	4 Oriskany, N. Y.	5 Onondaga, N. Y.	6 Hamilton, N. Y.
Machaeracanthus sulcatus *Newberry*	....	x				
Ctenacanthus	....	x				
Cephalaspis dawsoni *Lankester*[1]	....	x				
Pterygotus	....	x				
Tropidocaris belli (*H. Woodward*)	....	x	....	....	....	*
Phacops correlator *Clarke*	....	x	....	x		
Gyrichnites gaspensis *Whiteaves*	....	x				
Hyolithus *cf.* aclis *Hall*	....	x	....	....	....	x
Tentaculites cartieri *nov*	....	x				
Platyceras gaspense *nov*	....	x	....	....	....	*
Holopea wakehami *nov*	....	x	....	....	....	*
H. gaspesia *nov*	....	x				

[1] In describing this species [Geological Magazine 1870, p. 397] Lankester cites the notes of its occurrence transmitted to him by Sir William Dawson from which it appears that the specimen was derived from the Psilophyton and Prototaxites beds on the north side of Gaspé Bay, not more particularly noted. It was here also that the other fish remains cited by Dawson [Fossil Plants, pt 1, 1871] were obtained and apparently the invertebrate remains referred to by him as Dithyrocaris (subsequently described by Woodward as D. belli and evidently of the Devonic genus Tropidocaris), Ceratiocaris, Eurypterus, Pterygotus, Beyrichia, Lingula and Modiomorpha. By courtesy of the museum board of McGill University, through Prof. F. D. Adams, I have been enabled to examine specimens which appear to be in part the material referred to by Dawson, though they bear only the locality mark "Devonian, Gaspé." My comments on these specimens are as follows: the "Ceratiocaris" is plainly an impression of three plant stipes one above the other, making a trifid end; fragments of Pterygotus are evident and appear to be the same as those figured by Logan as Selaginites; the dark and olive shales contain a well defined Lingula and a small Modiomorpha or Carydium.

Gaspé Basin from the south; Southwest arm or York river in the foreground, Northwest arm or Dartmouth river in the middle distance. In the background hills of Gaspé sandstone behind which are the limestone ridges

FAUNA OF THE GASPÉ SANDSTONE (*continued*)

	1	2	3	4	5	6
	Grande Grève	Gaspe sandstone	Helderbergian	Oriskany, N. Y.	Onondaga, N. Y.	Hamilton, N. Y.
Callonema *cf.* bellatulum *Hall*	...	x	..	..	.	*
Pleurotomaria sulcomarginata *Conrad var.* leclercqi	....	x	....	...	...	x
Bellerophon *sp.*	..	x	...	....	..	*
Euphemus? quebecensis *nov.*	....	x				
Tropidodiscus brevilineatus (*Conrad*) (*Hall*)	...	x	...	...	...	x
T. rotalinea (*Hall*)	....	x	..	...	...	x
Aviculopecten	....	x				
Actinopteria fronsacia *nov.*	...	x	...	....	....	*
Liopteria?	...	x	....	....	....	
Grammysia canadensis *Billings*	....	x	...	....	....	*
Goniophora	...	x				
Modiella pygmaea (*Conrad*)	....	x	..	....	...	x
M. modiola *nov.*	....	x				
Phthonia cylindrica *Hall*	....	x		...	....	x
Sphenotus truncatus (*Conrad*)	....	x	...	....	....	x
Schizodus appressus (*Conrad*)	....	x	..	....	....	x
Palaeopinna flabellum *Hall*?	x	x	....	x		
Nuculites triquetrus *Conrad*	....	x	....	....	....	x
Palaeoneilo maxima *Conrad*	....	x	...	....	....	x
P. *cf.* constricta *Conrad*	....	x	....	....	....	x
Leda brevirostris *Hall*	....	x	....	....	....	x
Lunulicardium? convexum *nov.*	....	x				
Cryptonella *sp.*	....	x				
Rensselaeria ovoides (*Eaton*) gaspensis *nov.*	x	x	....	(x)		
Eatonia peculiaris (*Conrad*)	x	x	....	x		
Leptocoelia flabellites (*Conrad*)	x	x	...	x		
Spirifer gaspensis *Billings*	....	x	....	*	....	*
Cyrtina hamiltonensis *Hall*	....	x	....	....	....	x
Athyris hera *nov.*	....	x	....	....	....	*
Leptostrophia blainvillii (*Billings*)	....	x	....	....	....	*
Orthothetes becraftensis *Clarke*	x	x	...	x		
Chonetes billingsi *nov.*	x	x				
C. hudsonicus *Clarke* gaspensis *nov.*	....	x	....	(x)		
Chonostrophia dawsoni (*Billings*)	....	x	....	*		
C. complanata *Hall*	x	x	...	x		
Dalmanella pentouili *nov.*	....	x				
Hederella blainvillei *nov.*	....	x	....	*		
In this list close allies or possible identities are indicated by a *	7	48	o	8	o	13 (23)

Origin of the Gaspé sandstone

We have noted that, so far as observations upon the faulting of these rocks have extended, it would seem that displacements are of slight throw and not sufficient in their totality to greatly qualify the thickness assigned to them by Logan. So far as the sandstones alone are concerned we find the most rational explanation in the deposition in a great coastal lagoon receiving terrigenous sediment rapidly and in vast quantity from the highly elevated old land. This was an Old Red lake in the same sense as those of Scotland and that in which the Oneonta and Catskill sands of New York were laid down. How slender was the barrier which cut off the lagoon from the open sea is seen by the thin stratum with marine deposits which we may fairly say represents the overwash in time of stress of the outside water bringing in the marine organisms as we find them — dead shells from the littoral. We have evidence of more than one such inrush of the sea, for marine fossils have been found in more than one locality, and they probably lie at different horizons. The conglomerates, to which reference is again made on a following page, are the evidence of deposit on a bold and rocky coast; they indicate interruptions of lagoon conditions and imply such a sea front as exists today, and has prevailed for ages along the face of the Gulf about Percé.

The list of marine fossils presented above shows that the original determination of the age of these beds as practically equivalent to the Oriskany of New York is insufficient. The assemblage presents a strange and unusual combination. In majority of number the species are unquestionably those of the Hamilton fauna of New York,[1] but with these are several pronounced Oriskany species and those customarily regarded as indicial of that stage: Rensselaeria ovoides gaspensis, Orthothetes becraftensis, Leptocoelia flabellites, Eatonia

[1] Professor Hall was the first to express the opinion that some of these fossils submitted to him by Sir William Dawson had a Hamilton expression and Dawson himself, on several occasions, quoted and endorsed this view.

peculiaris, Phacops correlator. It is safer to consider these as indicative of and survivors from the Grande Grève fauna than to construe them as Oriskany elements. There is no problem here of unequal diffusion of the fauna through successive strata. Whatever their relative age elsewhere, all are found here commingled.

The Hamilton species indicate the introduction and prevalence of a fauna and a geologic stage much later than Oriskany, but the sea into which this fauna had encroached held surivors of the Grande Grève fauna. Of very great significance to the paleogeography of the country is the presence of this Hamilton fauna for it indicates a northeast passage at this late date from the Appalachian gulf through which the fauna departed eastward along the continental border. The problem presented here does not concern the inward migration of the fauna from the east as in the case of earlier faunas for incontrovertible evidence indicates that the fauna of Middle Devonic time arrived in the Appalachian gulf from the south along the Andes littoral. We may regard the path of advance indicated by the Gaspé sandstone fauna blazed by the outcrops on the north shore of the Bay of Chaleurs at Scaumenac and Maria from the first of which we have the fine Old Red fishes described by Whiteaves and from the latter indications of the marine fauna as noted by Ells and Low.[1] There should be in

[1] These writers have suggested the probability that the Devonic deposits referred to on the Bay of Chaleurs at Maria, Scaumenac and Campbellton were laid down in an area separated from the more northerly region here under consideration, by barriers of old land composed of upturned Siluric and Cambric strata. This seems to us an entirely probable condition but not without possibility of connection between the two basins at some point further westward. A fuller knowledge of the marine invertebrates reported from Maria will help to throw light on this point. Because of certain identifications of fossils from Port Daniel made by Billings, some doubt had rested in the writer's mind as to the possibility of the limestones and sandstones there which have been recorded as of Siluric age, being of later date. Port Daniel presents a rather unusual thickness of limestones greatly distorted and altered by contact with eruptives and these are highly fossiliferous though the preservation of the fossils is bad. At the head of Port Daniel bay extensive exposures have been recently afforded by bush fires and the gray limestones show themselves to be largely reefs of Stromatopora, Cladopora, Phillipsastraea, Favosites, Astrocerium, Halysites

the ultimate analysis of such a fauna a clue to the direction of its movement. Comparisons with the Hamilton fauna of New York taken as a whole fail to reveal such, but comparisons instituted between this particular representation of the Hamilton fauna and the later than Middle Devonic fauna of western Europe do indicate without qualification that the Gaspé sandstone species find their equivalents therein. Just as Tropidoleptus and Vitulina have pointed out the earlier migratory course of the fauna so these show its later and directory phases. There is therefore a harmony in the inception period of lagoon conditions along the Atlantic border and Appalachian gulf, for in New York these were initiated with the close of the Hamilton and in Gaspé not long, if at all, before the opening of this time. They do not, either here or elsewhere in eastern America, date back earlier.

Distribution of the Gaspé Devonic limestone and sandstone series toward the southwest

Logan, Bell, Ells, Low, Barlow and other members of the Canadian Survey have indicated the outcrops and boundaries of these formations inland in western Gaspé and in Rimouski counties. The summation of our present knowledge of their probable extent through central and northern Gaspé is depicted on Ells's geological maps of 1882–84. Few fossil lists have been given in connection with these western determinations but the

and Zaphrentis; with them being a few other identifiable fossils, Atrypa reticularis, a gastropod, Coelidum and the trilobite Calymmene blumenbachi or niagarensis. Over them lies a hard quartz sandstone which has certain rotted layers containing: Nucleospira, Whitfieldella, Camarotoechia cf. whitii, Clintonella, Stropheodonta like patenta and profunda; some of the coarse conglomerate blocks carry a Favosites, Murchisonia and Pterinea. Red limestones are shown with abundance of Diphyphyllum and Cladopora at the east side of the bay (Cap de l'enfer). Here they stand vertical while from this point westward their dip changes to southerly. In the beach intervals at Port Daniel and thence east to l'Anse au Gascon, the flat red conglomerates are seen overlying the upturned limestones. These limestones and sandstones are conclusively Upper Siluric. Their stratigraphy and paleontology will afford an interesting problem to some future worker.

record of successive anticlines as indicated by dip records on the maps referred to is very instructive.

Dr Ells has specially noted the widening of the belt of sandstones and limestones at the head of the Nouvelle and Cascapedia rivers to a diameter of 25 miles and its decrease eastward at the head waters of the Little Cascapedia and St Anne rivers to one half this width. Thence in its eastward sweep toward the coast the map we have referred to depicts the series as broken, Ells having represented as Siluric that part of the Gaspé limestones (St Alban, Cape Bon Ami) which we here consider Devonic. On Miner's brook, a western branch of the Cascapedia near the northern limit of the basin and 15 miles west of the Gaspé-Rimouski boundary, the following fossils were found, as identified by Dr Ami [Report, 1884, p. 23E]

Zaphrentis incondita *Billings?*	*Goniophora*
Orthis *allied to* O. vanuxemi *Hall*	Mytilarca
Orthis aurelia *Billings*	*Grammysia* cf. G. sulcata *Conrad*
Strophomena rhomboidalis *Wilckens*	Pterinea textilis *var.* arenaria *Hall*
S. sp.	Cytherodon *sp.*
Spirifer gaspensis Billings	Tentaculities *sp.*
Rensselaeria ovoides Eaton	Dalmanites *sp.*
Atrypa reticularis *Linné*	

The names in italic are species of the Gaspé sandstone on the coast. The combination lacks the stronger middle Devonic expression of the latter rocks and (if the species are all from the same beds) shows noteworthy addition of forms from the fauna preceding.

In Bonaventure county, constituting the southern part of the Gaspé peninsula, is the notable occurrence of the fish bearing beds on Scaumenac bay in the upper reaches of the Bay of Chaleur opposite Dalhousie, and just southward over the line in New Brunswick, a similar development at Campbellton. Dr Whiteaves[1] has given the history of these discoveries and he too has in various papers described and illustrated this remarkable fish fauna. The reader may find the entire literature pertaining to these

[1] See his address as vice president, A. A. A. S. section E, 1899, p. 16.

fishes summarized by Whiteaves in the work referred to, embracing in addition to his own accounts descriptions by Doctors Traquair and A. S. Woodward.

It may be noted that the species at the two localities cited are not the same and Sir William Dawson, who studied the terrestrial plants occurring in these beds arrived at the conclusion that the Scaumenac beds were the equivalents and continuation of the upper part of the Gaspé sandstone while the beds at Campbellton were identical with the lower part of that formation.[1]

Remains of Pterygotus and minute holostomatous Valvata-like gastropods which, in lack of more exact knowledge, have been called Cyclora (C. valvatiformis and C. turbinata Whiteaves) occur at Campbellton. The evidence is in entire accord with the conviction already often expressed that those beds are still the lagoon deposits which inaugurated and characterized the period of the Gaspé sandstones.

St Helen's island, Montreal. Logan indicated the Helderbergian age of the limestone masses which are supposed by him to represent much disturbed lenticular strata "lying in or under the conglomerate" composing most of this island and resting on Utica shales. The fauna has been recently and clearly analyzed by Schuchert who concludes in reference to the structure of the island as a whole that the disturbance of the Helderberg strata antedates the deposition of the conglomerate which contains blocks carrying species suggesting a middle Devonic age, though these are few and none too certain in their indications. The Helderberg fauna here cited by Professor Schuchert is as follows.

Rhipidomella *cf.* musculosa *Hall*
Stropheodonta varistriata *var.* arata *Hall*
Rhipidomella *cf.* oblata *Hall*
Strophonella punctulifera *Conrad*
Spirifer concinnus *Hall*
S. murchisoni *Castelnau ?*

[1] Fossil Plants of the Erian and Upper Silurian Formations of Canada, pt 2.

Plethorhyncha pliopleura *Hall?*

Rensselaeria aequiradiata *Hall*

Chonostrophia montrealensis *Schuchert*

In addition to these, Logan's list contained Favosites gothlandica, Leptaena rhomboidalis, Athyris (Meristella) bella and Atrypa reticularis.

Logan records the presence of the later conglomerate nearby at Round Island and Isle Bizard; also on the Rivière des Prairies east of the latter and near St Eustache to the west, so that the middle or later Devonic transgression of conglomerate appears to have been of considerable extent. It may here be provisionally stated that there is no satisfactory evidence for inferring at any date a direct connection between the small Helderberg-Oriskany basin about Montreal and the New York deposits of the same period. This point will receive further consideration.

Mines and Petroleum. The controlling impulse in all the early voyages to the New World was two-fold, to find a western passage to India and the discovery of gold. Gold was among the earliest quests upon the Gaspé coast and though it was never found yet amongst the earliest records of Gaspé is the discovery of silver-bearing lead at Little Gaspé on the Forillon, and a company was organized in France to exploit it. Even the Jesuit missionaries seem to have become embroiled in this enterprise for the "Relations" record with some pathos the fact that in 1663 Father Balloquet returned from Gaspé "not having found his mine good." I suppose, perhaps, without final evidence, that this refers to the Little Gaspé vein, which is the largest of all that are known on the Forillon and the ancient tailings of which are seen today covered by the refuse of later ventures, all of which have had the same outcome. But these lead-bearing veins, cutting straight across the mountains along lines of slight displacement of the rock masses are of frequent occurrence along the little peninsula and there are "mines" at Grande Grève, Indian Cove and St George's Cove. It is evidently of the Little Gaspé mine that Denys speaks with so much emphasis and detail: "One league further up the river [Gaspé Bay] is a cove where one can set foot on the ground. On the high ground is the place where it has been hoped to find a lead mine and Messieurs de la Compagnie have paid the cost on the representations of persons who had brought some fragments that were veritably good but they are only from some little veins that run over the rock and which the force of the sun has purified, for the whole mine is only antimony and that not very abundant. I have known of it for more than twenty years.[1] If it had been good I should not have let it be idle. I have found plenty of persons who were ready to undertake on shares what I have seen, but I was never willing knowing well that I should deceive them and that is something I am incapable of doing unless I were myself deceived without knowing it." Between that date and this no one knows how many times these old veins have been rediscovered. It is not many years since an

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[1] That would be at least as early as 1652.

Bonaventure conglomerates

Over the tops of the broken and decapitated folds of sand, limestone and conglomerate in Gaspé county lies a mantle of coarse clastic material partly sand but chiefly jasper and limestone conglomerates. These strata do not appear north of Gaspé bay and are chiefly confined to the mountains about Percé and to Bonaventure island. Sandstones and conglomerates together may attain an elevation of 1500 feet represented by the Percé mountain and they have a gentle and apparently uniform dip to the north, not often exceeding 10° and generally less. These constitute the Bonaventure formation of Logan and were regarded by him as of early Carbonic age.

English company stripped off great patches all along the hillsides from Little Gaspé to Grande Grève in a mad and misdirected search for the short cut to wealth.

Had nature been less wise Gaspé might have been a great oil field, with today its distant reaches dotted with derricks and a row of palaces extending back from Gaspé Basin to the Mississippi.[1]

If the hopes of fifty years were realized and oleaginous money had been pumped out of the earth, Gaspé would ere this have lost its bloom and be like any other place, its people like any other people. The story of the hunt for petroleum in this region is I believe that of the most tenacious and costly pursuit of an ignis fatuus known in the history of oil development. Indeed for half a century the golden goal has seemed ever at hand and today never so far away. Oil was found by the early geologists and known before their coming, oozing from the sandstones on the south shore of Gaspé Bay particularly near Tar Point and Point St Peter, where one of the anticlines emerges at the water's edge.

In 1863 Logan published his final geological report on this country and this was followed by a special report on the petroleum by Hunt in 1865. This was near the period of rapid development of the petroleum production in Pennsylvania and though the anticlinal theory of oil accumulation had not been formulated so early, yet private enterprise began the drilling for oil along the inland extension of these anticlines into the region about the upper reaches of the York river. It is not my purpose to enter into detail in regard to the persistent effort to obtain this product during this long period. Companies were organized on British capital and companies were syndicated ; new companies representing other capital appeared and were syndicated. The map we have here inserted indicates the number of wells that have been driven, some 35 in number, some of them to the great depth of over 3000 feet. It shows also the location of the refineries, and may convey some conception of the enormous expense involved, for all apparatus for drilling and refining has had to be brought in by water from the States and hauled over rough roads through the wilderness for 20 to 30 miles. Vast sums doubtless have been spent and all the labor and all the expense ever in the hope of finding oil. The refineries were built to refine the oil it was hoped to find, not oil that had been found, and new wells were sunk not to find

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[1] A little stream about 35 miles back from the Basin where the oil operations have been most actively carried on.


Sketch Plan of
GASPE OIL-FIELDS
Shewing
LOCATION OF WELLS
From a Report by R. W. ELLS, LL.D. 1902
INDEX
Petroleum Oil Trust
Canada Petroleum Co.
International Oil Co
Oil springs
Barometric heights above sea
Dips
Faults
Anticlines
GASPÉ BAY NORTH
GASPE BAY SOUTH
North West Bay
LAROCQUE
GALT
YORK
BAILLARGEON
LAFORCE
DOUGLAS
YORK RIVER
ST JOHN RIVER
MALBAIE ANTICLINE
POINT ST PETER ANTICLINE
TAR POINT ANTICLINE
HALDIMAND ANTICLINE
Very hilly and broken country
Cape Haldimand
Cape O'Hara
Sandy Beach
Douglastown
Third Lake
Fourth Lake
Second Lake
First Lake
Porcupine Pt
Navarre Pt
Anse aux Cousins
Peninsula
Basin
Adam Pt
Scale 2 miles to 1 inch
Chains
Miles
Location of wells and tracks, from plans supplied by the Petroleum Oil Company

At places, as south of the Robin beach at Percé, the lower beds are fine feldspathic red, green or gray sandstones, but even these carry pebbles and the prevailing character of the formation is conglomeratic. South of the region under immediate consideration, sweeping along all the country on the north shore of Chaleurs bay and into New Brunswick, these deposits are widespread.

It is by no means easy, with present knowledge, to determine the true age of these deposits. In considering the commonly accepted view of Logan and his successors expressed above, we are confronted by phenomena at Percé and thence north to Point St Peter which seem to us to render this conclusion less secure than observation of the more southerly outcrops would induce. Strata of conglomerates composed of

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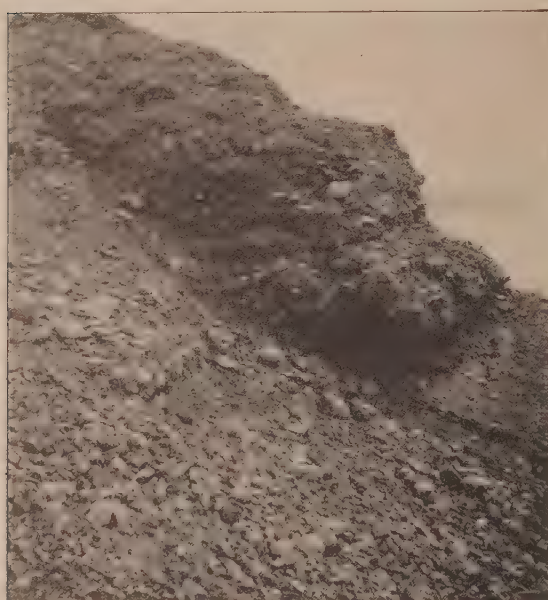
more oil but only in the hope of finding some oil. The successive managers of the companies have lived in enviable magnificence at the Basin in the same hope of discovery. Nothing has seemed to me, a passing observer, so out of harmony with the spirit of the country than this display of prosperity with only a bubble behind it. Yet the hope has I believe all been fully justified. The sandstones into which the drills have gone are saturated with petroleum and there must indeed be an enormous total amount of this material in the strata. But nature seems to have made no proper provision for its accumulation. Practice on the theory of storage in pools parallel to the anticlines, which has been so fruitful in other Appalachian oil fields has here been without result. The folds are there, and their troughs into which the oil might settle by gravity, but somehow it has got away. All external conditions for extensive production are absolutely favorable and attractive. But there is no oil. The total product of all these years is the little that has been accumulated in the bottom of the wells and been pumped out. I have been in no position to form an explanation of the real cause of this condition, but it is my suspicion that through cracks and joints in the folds and troughs the oil which might have accumulated therein has gone on further down and out of reach of the drill. Gaspé as an oil field is deranged.

Gaspé can not make a home for miners of any kind, for there are no mineral deposits of any present moment in it. Gaspé Basin being a magnificent harbor became a busy little port of passage, its gentle eastern and southern slopes have made some small farming possible while its rivers are the nurses of a busy lumber trade.

It is the submarine topography of Gaspé that fixed the business of its people from the dawn of its civilized history. Its seas are washing over the devoured continents and their shallow rocky bottoms are the home of the cod. The ancient unceasing warfare between sea and mountain has cut out for Gaspé its occupation for all time. Its history and its civilization, its stories of fortunes acquired or oftener of meagre livings wrested from the sea have all their origin, like the picturesqueness of its scenery, in the geology of the country. "Que voulez-vous!" exclaims the Abbé Ferland; "It is the land of the cod. By your eyes and by your nose, by your tongue and your gorge and by your ears as well, you are soon convinced that in the Gaspesian Peninsula the cod forms the basis of aliment and amusement, of business and conversation, of regrets and hopes, of fortune and of life and, I venture to say, of society itself."

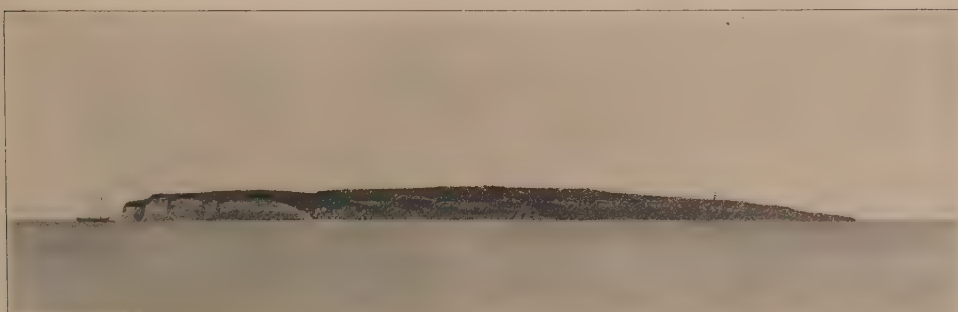
pebbles carrying Siluric and Devonic fossils from the beds beneath[1] and included by Logan in the Gaspé sandstone group, are found at various inclinations from Chien Blanc on Gaspé Bay all the way around Malbay to the Grande Coupe at Percé; at places these beds are nearly horizontal, from Cannes de Roche to Corner of the Beach on the south shore of Malbay they are nearly vertical and their color varies from red to ashen gray. In lithologic composition, the nature of the component pebbles and in the general aspect of this northern series there is no distinction from that comprising Percé mountain and Bonaventure Island. This latter, the typical expression and section of the Bonaventure conglomerates, stands with abrupt and sheer escarpments on the east and north telling, like the Catskills, of a widespread further extension. The stratigraphic distinction between these higher Bonaventure conglomerates and the lower conglomerates of Malbay is only the apparent unconformity between the two. The gently sloping higher mass of Percé mountain seems to lie directly on the vertical conglomerates of Cannes de Roche and it is the indication of this sharp unconformity that has been regarded as evidence of the distinction in age in the two parts of this great



Limestone conglomerate, Mt Ste Anne

[1] The following species have been noted: Dalmanites biardi, Chonetes canadensis, Meristella champlaini, Spirifer murchisoni from the Percé limestones; Calymmene and several species of brachiopods from the hard quartzite pebbles; Heliolites, Plectambonites sericeus, etc., from the lower limestones—a list which might be much increased with further search.

homogeneous mass of conglomerates. My examination of the sea-wall from the Murailles at Percé to Corner of the Beach, leads me to the impression that the erect conglomerates at the latter place, cut off, as they are, to a narrow shore belt by the Siluric limestones behind, have been downthrown from their normal position along the zone of great disturbance which has involved the Murailles, Cape Barré, the sea-floor outside the North Beach[1]



Bonaventure island, from the Robin beach, at Percé

and Percé rock. No fact impresses the casual observer more forcibly than the apparent presence of the extensive unconformity between these Bonaventure beds and the lower conglomerates, but the appearance is, I am confident, illusive and the Bonaventure conglomerates seem to represent a southern slightly undulated part of the same conglomerate mantle which appears more highly faulted in the anticlines further north. Such an interpretation involves several important conceptions.

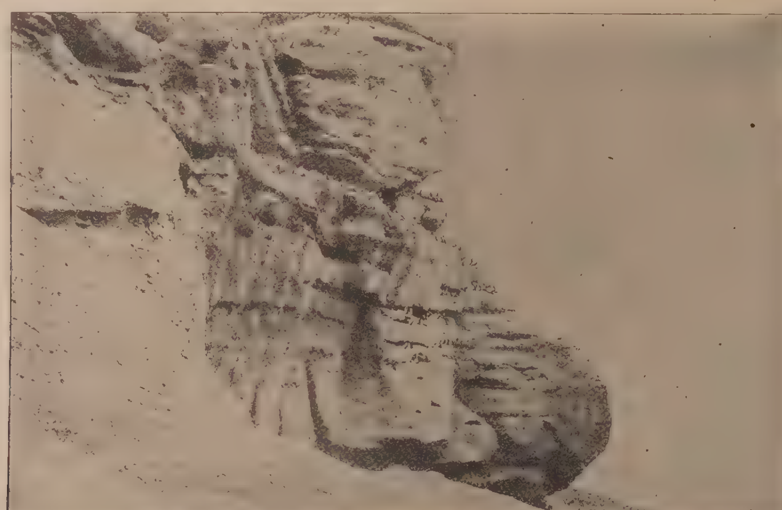
1. These conglomerates were certainly laid down unconformably on the vertical edges of the Devonic and Siluric strata about Percé.

2. As the Gaspé sandstones of Gaspé Basin have been folded up together with the Devonic limestones of the Forillon, either the Gaspé sandstones of the north are older than the entire series of conglomerates or the folding at the south, which involves the Devonic limestones and the

[1] At low tide the strata beneath the water here show clearly the existence of a minor fault which has dislocated the beds in such a way that while those to the south of the wharf are parallel to the beds of Mt Joli, at the north of the wharf the angle changes to a much more easterly strike.

Siluric strata together, was earlier than the upturning of the Devonic limestones at the north with which the older strata were not involved; or both conclusions are probable.

3. While the sandstones constituting the lower part of the "Gaspé sandstone series" and their presence in the higher beds are indicative of barachois or lagoon conditions, the conglomerates themselves are clearly open coast deposits formed under such circumstances as prevail today wherever these very rocks are exposed to the play of the sea.



Bonaventure conglomerate — Gannet cliffs, north side of Bonaventure island (By courtesy of Mr L'Esperance, Percé)

4. That the Bonaventure conglomerates of this typical section, either in whole or in part, are of Carbonic age is probable only in a sense that their formation began in late Devonic time and continued without effectual interruption into that of the subsequent era in the same sense perhaps as the upper beds of the Catskill group of New York seem to be of a Post-devonic age.

These strata constitute the latest of the rock deposits in Gaspé.[1]

[1] In this connection the following is worthy of record. About three miles from Gaspé Basin on the lower side of the York river, submerged beneath the water at high tide, rounded by wear and overgrown with water plants and bored by marine sponges, I

MT STE ANNE

Percé

Painted by Frederick James

The Gaspé Geosyncline

The foregoing details of the apparent geological structure of Gaspé are supplemented in the following pages and plates by the immutable facts on which must be based all inferences relating to the faunal problems. The latter will be subsequently considered. Apart from these, however, we may here briefly contemplate the significance of the great crustal depression in whose sediments these faunas are found.

A geosyncline is not properly conceived as a depression bounding an existing or an ancient continental mass but isostatic equilibrium requires that if there is a continental surface at one side of such great depression there will have been a similarly stable continental area at the other. This view has been forcibly expressed by Haug[1] as the essential condition of such depressions. Therefore in view of this conception we predicate with confidence a continental area outside and eastward of the great Appalachian depression, during all the period of deposit of the sediments now filling it. Appalachian land now reduced to a region of coastal folds, representing the deposits made in this geosyncline is left standing at the margin of the continental mass by the invasion of the sea over all but the merest remnant of the more ancient land area at the east. We are not likely too strongly to emphasize the fact that a geosyncline, though a line of weakness and mobility of the crust, is in its essence a seaway, a channel

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have found, lying with fossiliferous boulders of Gaspé sandstone, a block of gray and pure crinoidal limestone profusely filled with specimens of a large Productus. The species has a finely ribbed surface, spineless except for suggestions along the hinge, thick shell with deep muscle scars, heavy cardinal process; features which characterize the Productus comoides Sowerby of the European Coal Measures, but I do not find that it possesses the broad hinge areas and ventral teeth which led Waagen to place this species in his genus Daviesiella. It is like P. cora d'Orbigny but a heavier shell. At all events it is a Coal Measure fossil. Whence this specimen came I would not venture to say. No evidence of such rock beds exists in the country but the past 250 years have brought ballast to these shores from many ports, from France and England, Portugal and the Brazils, which may well have furnished such a block.

[1] Soc. Géol. de France. Bul. 1900, 28, 632.

between stable continental areas, whether its margins be elevated or submerged, for this conception becomes most pregnant in its relation to the transmission and dispersion of faunas and in the interpretation of bathymetric differences or facies therein.

It has been the view of several authors that in the progressive deformation of the lithosphere primary elevations and plications are circumpolar and concentric and secondary or later plications converge toward these polar regions. We need go no further afield than to cite the Canadian old land or "shield" in what, in terms of geography, is the western hemisphere and the Scandinavian shield in the eastern, as remnants of circumpolar masses now badly shattered; and the Appalachian mountains, its sister chain the Urals and the Rocky Mountain system, as examples of the meridional converging secondary plications.

Gaspé presents us with that most singular curve of the Appalachian system in which the course of the axis of plication changes into a sigmoid bending from the south, east and downward like the upper curve of the letter S. It is here that it loses its meridional direction and conforms in curvature to the margin of the old Canadian Archean shield against which it lies. The crystallines and eruptives of the Shickshock mountains, so far as analyzed, are probably to be regarded in part as the effusive incidents in the uplift and plication of the geosynclinal beds; in eastern Gaspé similar evidences of intrusion are not wanting. The original and approximately east and west depression which bounded the Canadian shield is still expressed by the basin of the lower St Lawrence river which the seas of all later ages since the erosion of the primary uplift have invaded.

The plicated precarbonic rocks which bound the margin of the Canadian shield seem to owe the present direction of their folds to the course of the original margins of the old land. The history of this northern or oldest part of the Appalachian geosyncline in Gaspé is essentially thus: The plication of the deposits in the great trough began by the upturning of the Cambric slates at the north covering the area beneath and somewhat to the south of the St Lawrence, in folds parallel

Percé. Red peak, the highest point of the Murailles. Vertical hight above the water about 700 feet

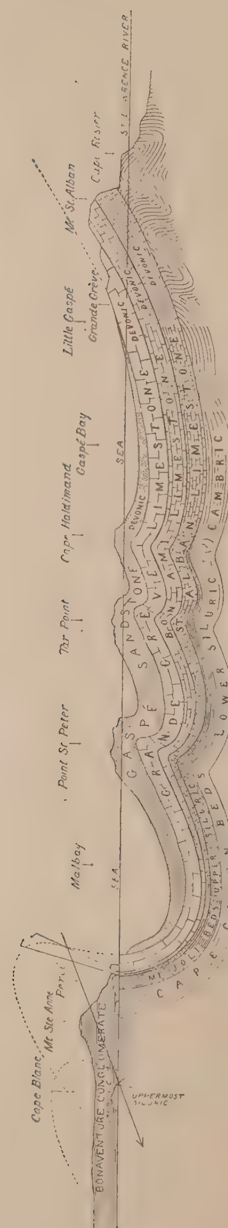
The gorge in Percé mountain, looking toward Malbay ; Red peak at the right

to the circumpolar shield; the plication that followed brought up at the north the next later deposits present in this section ("Cambro-Siluric") the different series being entirely unconformable. We have elsewhere recorded the evidence which indicates that dark shales are the deposits of considerable oceanic depths, a view confirmed by the course of reasoning adopted by Haug and others. It is, therefore, justifiable to conclude that in any normal geosyncline the first plications, being the upfolding of the deepest sediments, will be presumably constituted of dark shale beds. The Gaspé depression exemplifies this procedure in the upturning of its primary folds. Then at the north followed, during a long period, the subaerial erosion of these unconformable and highly plicated east and west folds, the younger being worn away from above the older and leaving this latter exposed today along a zone south of the former. Thereafter was a period of rest and active deposition in the geosyncline that ensued before the renewal of plication. Fifteen hundred or more feet of limestones had been laid down in the shallowing depression and then by abrupt change in drainage and in part through locking out of the sea by distant barriers some thousands of feet of sand and conglomerates followed one on the other all in essential conformity.

The limestone as well as the sands are the indication of lessened depth, of deposits shoreward of the shale-mud banks and raised above the level of the primary line of weakness and folding; hence they constitute only secondary plications along the geosynclinal depression.

During this vast period of quietude the geosynclinal area of deposition had narrowed by elevation at the north of the primary folds, but we have shown that the colored Devonic limestones about Percé though then still lying flat on undisturbed earlier sediments were brought so near to the surface, as to receive none of the deposits of the lower Gaspé sandstone which were laid down on them at the north. It was really but a slight epirogenic change here that shifted the calcareous muds into the lagoon conditions which led to the deposition of the Gaspé sandstones conformably upon them.

The geosynclinal deposits at the south involving the Percé Devonic



The Gaspé syncline along the coast from Percé at the south to Cape Rosier at the north, showing the various anticlines riding on this depression which are more clearly pronounced further inland; at the south (the left) is a suggested explanation of the occurrence of the Lower and Upper Siluric (not Upper Siluric alone) at Cape Blanc, by backward slipping along the plane of an overthrust fault

limestones and Siluric shales but not the Gaspé-Bonaventure conglomerates were upfolded and remained above the reach of the waters during the deposition of the Gaspé sandstone at the north.

Then followed at the north the upturning of the successive anticlines in which both Devonic limestones and Gaspé sandstones are together involved, and finally the depression during the Gaspé-Bonaventure stage and overwhelming of the Percé anticline by the encroaching mantle of conglomerates resulting from its own ruin.

The Gaspé syncline, or that portion of the great geosyncline which included Gaspé county, was thus filled up. The last of its plications were the successive waves which involve the ten thousand feet of Devonic limestones and sandstones at the north, and the final stage of deposition was begun with the quiet submergence of the plicated area at the south and closed by its reelevation into a plateau mantled with the gently dipping beds of conglomerate.

It has been the observation of some writers, Suess especially, that meridional mountain systems are generally attended by areas of independent flexure, gentle in degree, such as are indicated by the so called Cincinnati dome and like areas west of the Urals. To these the author cited has applied the term *parma*. We may here direct attention to the areas of early middle and late Siluric rocks whose exposures are now to be seen in the region north of the Gaspé geosyncline, in the Island of Anticosti, the Mingan islands, along the straits of Belle Isle on the Labrador and across

these straits in northern Newfoundland, all lying essentially flat or in very gentle slopes. The essential differences in attitude between these strata and those of Gaspé have been effectively brought out in the description given by Logan, Bell, Murray and other Canadian geologists. The straits of Belle Isle thus appear to be only a waterway located by a probable fault line and in no way comparable to the lower St Lawrence valley. It is evident that these shattered remnants of continuous Siluric strata do not constitute a "parma" but their strike still shows a parallelism to that of the Gaspé folds. It is to be noted that the Archean shield, now broken into, had an evident former continuation well south into Newfoundland. We conceive that its margin, extending south over the present Gulf of St Lawrence and into Newfoundland, was invaded by relatively shallow waters depositing the calcareous Siluric beds beyond the active line of plication and these beds may, therefore, stand in the same tectonic relation to the Gaspé folds as the paleozoics of central and western New York to the Appalachian geosycline at the east. We have stated above that the Appalachian system of plication ends at this eastern end with the Forillon peninsula and its buried remains reaching seaward to the submerged "American bank." Here at the north the plication ceased, though Devonic beds of the age of the Gaspé sandstones are known to lie over the flat Silurians of northern Newfoundland.

The termination or breaking down of these folds, whether due to abutting abruptly against the Archean old land or to an earlier syntaxis or "Schaarung" in the folds of the Archean itself is sufficiently indicated by the very presence of the Gulf of St Lawrence, which is the opened and invaded basin of the ancient Devono-Carbonic gulf whose deposits now line its eastern and western shores. The horizontal position of these deposits lying above the folds indicates how free of disturbance this basin for most of its extent has remained since the opening of Carbonic time. The Gulf of St Lawrence thus seems to represent the ancient cincture and attendant breaking down of the margin of the old land at an angle of syntaxis, and the accessory phenomena of eruption and effusion are present

along all remaining shore lines. Logan and his successors have regarded the course of the St Lawrence river as the locus of a great fault,[1] and it is entirely within reason to assume a displacement of the sedimentaries against the Archean land along this course; yet the assumption of this great fault does not to us seem essential to the interpretation of the structure of the region nor a necessary accompaniment to the plication of the great geosyncline.

[1] See the delineation of its course on the general geological map of Canada, 1882.

Compiled and drawn by R W Ells, assisted by A P Low
from plans made by the Crown Lands Department, Quebec, and the Geological Survey
Geologically surveyed by Logan, Murray, Richardson, Bell, Ells and Low 1843-83

Emended by J M Clarke
1906

Geological Map of the eastern part of Gaspé

DESCRIPTIONS OF GASPÉ FAUNAS

I FAUNA OF THE ST ALBAN BEDS

Phacops logani Hall

See further p. 118

Grande Cavée of Griffon Cove river.

Dalmanites griffoni nov.

Plate 7, figure 4; plate 9, figure 4

There occurs in the Grande Cavée outcrops a Dalmanites having the characters of D. micrurus Green. In lobation of tail there is little to distinguish it from that species and the general outline of the head and of the glabellar lobes is similar, but in excavating these fossils from the compact residual clay into which the rock has altered I observed and made sketch of a cephalon on the anterior limb of which was a very pronounced elongate and spatulate extension, as is represented in outline in our figure. This was so fragile that I was unable to preserve it and no other specimen of the cephalon was complete in this frontal region. It is such a prolongation or snout as one sees in Salter's figure of D. longicaudatus (British Trilobites, 1864, pl. 3, fig. 19) from the Wenlock shale which one may regard as an incipient condition of the Probolium condition. It seems, hence, eminently appropriate to find this development accompanying a condition of complete glabellar lobation characteristic of true Odontochile, and likewise to find this expression of Dalmanites in earliest Devonic as well as in latest Siluric rocks.

Dalmanites coxius nov.

Plate 7, figure 1

Among the specimens loaned for this study from the collections of the National Museum is a rather large pygidium labeled as from "between Cape Gaspé and Cape Rosiers." This locality would seem to be along the line of the road leading from Grande Grève to Cape Rosier as the rocks are not elsewhere accessible in this region except by cruising about Shiphead and along the coast. This pygidium is subequally triangular and distinctly flat with relatively narrow axis and broad sides. The margins have a slight outward curve and meet behind in a short broad caudal spine. The pleural ribs extend very nearly to the margin and on the cast they appear to be elevated abruptly on the posterior edge and slope gradually from this edge upward. The same character is noticeable on the segments of the axis. The intervening grooves are thus not sharply defined except

at their upper margins. There are 12 of these flattened shelving ribs on the pleura and 12–15 on the axis. Each of the pleural ribs shows trace of a fine surface groove. The test is very thin and its surface so far as known very finely granulate. The specimen has a length of 35 mm and a width of 44 mm. I should be at a loss for a known species with which to compare this tail. In respect to the character of its segments and its thin test it is like D. limulurus, the well known Upper Siluric species of New York, but therein the resemblance ceases.

Species name. Nicholas Cox, governor of Gaspé after the English conquest.

Bronteus barrandii Hall

Plate 9, figures 12, 13

Bronteus barrandii Hall. Palaeontology of New York. 1859. 3 : 350, pl. 73, fig. 1–4

Bronteus canadensis Logan. Geology of Canada. 1863. p. 391

This species is one of the rarest in the fauna of the New Scotland beds (Helderbergian) in eastern New York and has not been elsewhere found save at the locality here considered. The description was based on a series of pygidia only but the writer has collected the other parts so that the species is pretty well understood. All New York specimens of the pygidia are of uniformly small size, bear an entire and spineless margin, a broad flat median rib with seven narrow and subequal ribs on each side. We have a single pygidium agreeing with these New York specimens in all details even to size, obtained by me in the St Alban beds in Cape Rosier Cove.

The name used by Logan as above cited doubtless had reference to this species. We elsewhere note the presence of a large varietal expression of B. barrandii in the fauna of Stewart's Cove, Dalhousie.

Cordania cyclurus Hall & Clarke

Phaethonides cyclurus Hall & Clarke. Palaeontology of New York. 1888. 7 : 137, pl. 24, fig. 26, 27 ; pl. 25, fig. 11

A cranidium of this species has all the characters, even to size, of the originals from the New Scotland beds of Clarksville, N. Y.

Locality. Lower 70 feet, Cape Rosier Cove.

Kionoceras cf. **rhysum nov.**

See p. 142

Grande Cavée, Griffon Cove river.

Cyrtoceras albani nov.

Plate 13, figures 6, 7

This is a quite common shell in these beds, having a long slender and gently curved cone, broadly swollen on the body chamber and constricted behind the aperture. The greatest curvature is in the later parts of the shell, the earlier portion being quite straight for a short distance. The septa are regularly concave and close together, the surface ornamented by very fine elevated threadlike eccentric lines. The species is not unlike the Cyrtoceras subrectum Hall of the Helderbergian, whatever generic form that may prove to be when better known.

Locality. In the lower beds, Cape Rosier Cove.

Conularia lata Hall *mut.*

See p. 144

Forms agreeing with those assigned to this species from the higher strata occur in lower beds of Cape Rosier Cove.

Probolaeum ? canadense nov.

Plate 17, figures 1, 2

We are disposed to regard as a representative of the Polyplacophora or chitons an elongated semicone-shaped plate sinuate on its front margin, with a posterior terminal beak and broadly enfolded posterior margin. The characters of this plate are shown in the figures drawn from a sculpture cast, displaying the sharp concentric growth lines which are crowded together on the enfolded part of the test. The length is 28 mm and the anterior width 19 mm.

In the Devonic of the Appalachian gulf no chitons have been found, though these bodies are known from several horizons in the transatlantic Devonic. There is noteworthy similarity in the form and aspect of P. canadense to Chiton sagittalis Sandberger (Stringocephalus limestone).[1]

Locality. Cape Rosier Cove.

Pleurotomaria labrosa Hall

Plate 16, figure 18

Pleurotomaria labrosa Hall. Palaeontology of New York. 1859. 3:339, pl. 66, fig. 1–5; pl. 67, fig. 6

This striking and rather remarkable species which has not before been found outside of the Helderbergian (Becraft and New Scotland limestones)

[1] Verstein. rhein. Schichtensys, p. 239, pl. 26, fig. 23.

area of New York, is represented in these collections by a single imperfect but wholly characteristic specimen.

Locality. The lower beds at Cape Rosier Cove.

Lophospira bilirata Hall (sp.)

Plate 16, figure 19

Murchisonia bilirata Hall. Palaeontology of New York. 1859. 3:299, pl. 55, fig. 2

I identify with this little known shell from the New Scotland beds a turreted species with subacutely sloping whorls, the edge of which bears a narrow slit band and the upper and lower surfaces are covered with very fine crowded striae with retral curve to the periphery.

Locality. The Grand Cavée.

Eotomaria cartieri nov.

Plate 16, figures 21, 22

Shell rather small with low spire, 3–4 whorls, broad at the base. Slit-band sharply defined lying at or making an angle of about 90° between the lower and upper divisions of the whorls, the lower surface being convex and the upper slightly concave or flat. As the sutures are deep and the slit-band well elevated above the suture line the whorls have a sharply step-shaped appearance. The sculpture, so far as observable, consists wholly of concentric growth lines. Width of base in the original specimen 20 mm; hight of spire 18 mm.

Locality. Grande Cavée of Griffon Cove River.

Specific name. Jacques Cartier, intrepid discoverer of New France, who erected the insignia of his sovereign just across the Bay from this spot, July, 1534.

Actinopteria textilis Hall

See p. 156

As in the New Scotland beds of New York.

Locality. The Grande Cavée.

Limoptera rosieri nov.

Plate 20, figures 1, 2

This large and rather fine species has a flabellate outline with umbones almost at the anterior end of the hinge. The hinge line is very long and straight terminating posteriorly on the extreme point of a very broad posterior wing. The incurvature from this wing toward the body of the shell is but slight, but the area is set off by a low, broad depression on the surface and a distinct change of curvature in the surface lines. The body of this shell is broad and transverse, the curvature being regularly suboval, while

the anterior course of the margin is much more direct, curving outwardly below and slightly incurved above. The anterior wing is very small, separated from the umbones by a deep sulcus. The ligament area is very broad and is longitudinally lined. The ornament lines of the surface consist of distinct concentric lamellae, becoming more closely arranged near the margins. Their interspaces are crossed and the lamellae themselves notched or crenulated by subequally distant elevated radial lines. The reticulated and fimbriated effect is specially shown on the posterior wing. Our specimens show the following dimensions: Length on hinge, 100 mm, hight and length of body, 90 mm.

Locality. From the lower beds, Cape Rosier Cove.

Modiomorpha varia Billings (sp.)

For description *see* p. 115

Specimens here are like the smaller of those from the Grande Grève beds but are seldom well preserved.

Locality. Lower beds, Cape Rosier Cove and at the Grande Cavée.

Goniophora mediocris Billings

For description *see* p. 161

I am disposed to identify with this species from the Grande Grève limestone, shells somewhat narrower and more elongate from the upper beds of Cape Rosier Cove and probably also from the Grande Cavée.

Leptodomus canadensis Billings

For description *see* p. 160

Specimens much better than any seen from the Grande Grève limestones occur at this horizon.

Locality. The lower beds of Cape Rosier Cove; probably at the Grande Cavée.

Mytilarca nitida Billings

For description *see* p. 159

Rather poorly preserved examples occur in the argillaceous limestones.

Locality. Lower beds, Cape Rosier Cove.

Palaeopinna flabellum Hall

See p. 159

This is one of the more common of the species, similar in all respects to the specimens in the Grande Grève limestone, even bearing the Crania (C. grandegrevensis) which accompanies the latter.

Locality. Lower 70 feet, Cape Rosier Cove.

Cypricardinia planulata Conrad (sp.)

Pterinea planulata Conrad. Jour. Acad. Nat. Sci. Phila. 1842. 8:251, pl. 13, fig. 15

Cypricardinia planulata Hall. Palaeontology of New York. 1885. 5:484, p. 1, 2, pl. 79, fig. 1–5

This very characteristic though rare species of the Schoharie grit in New York has a normal expression here, its elevated crescence ridge, low and depressed posterior slope distinguishing it.

Locality. Upper layers, Cape Rosier Cove.

Camarotoechia semiplicata Conrad (sp.)

Plate 28, figure 1

Atrypa semiplicata Conrad. An. Rep't Palaeontology of New York. 1841. p. 56

Rhynchonella semiplicata Hall. Palaeontology of New York. 1859. 3:224, pl. 29, fig. 1, a–o

A diminutive shell recognized by its subequal valves, smooth surface with a pair of coarse plications on each side of the median line near the margin. It occurs in the Coeymans limestone of New York and in a subcrystalline limestone at Cape Rosier Cove and at the Grande Cavée.

Camarotoechia cf. **altiplicata** Hall

See Rhynchonella altiplicata Hall. Palaeontology of New York. 1859. 3:231, pl. 33, fig. 2, a–k

With this species may be compared a series of shells agreeing in essential characters but carrying persistently but a single plication in the sinus and two on the fold. This arrangement occurs but does not necessarily prevail among the New York (New Scotland) fossils.

Localities. The Grande Cavée and Cape Rosier Cove.

Uncinulus vellicatus Hall

Rhynchonella vellicata Hall. Palaeontology of New York. 1859. 3:230, pl. 33, fig. 1, a–p

Common at the Grande Cavée and in the New Scotland beds of New York.

Sieberella galeata (Dalman) Hall

Plate 29, figures 31, 32

Pentamerus galeatus Hall. Palaeontology of New York. 1859. 3:257, pl. 46, fig. 1, a–z; pl. 47, 1, a–m

Pentamerus galeatus Billings. *op. cit.* p. 41

The specimens of this species are unqualified, all of them showing more or less decided evidence of plication and they appear to vary within the

limits customary to the Pentamerus galeatus of the Coeymans limestone of New York.

Locality. Common in the lower division at Cape Rosier Cove. Billings cites it from division 1.

Atrypa reticularis Linné (sp.)

The expression of this species in the Helderbergian of New York is quite decided and peculiar. The shell is always of medium size, compact, with valves devoid of fringes and lamellae, rather elongate in outline with a distinctly projecting ventral beak. This style of the species is impressed pretty constantly on all its examples. The same expression is maintained by specimens from the lower beds of Cape Rosier Cove.

Rhynchospira formosa Hall

Rhynchospira formosa Hall. Palaeontology of New York. 3:485, pl. 36, f. 2

A single very characteristic specimen of this Helderberg species has been found at Cape Rosier Cove.

Rhynchospira globosa Hall

Plate 29, figures 14–17

Waldheima globosa Hall. An. Rep't State Cab. Nat. Hist. 1856. p. 47
Trematospira globosa Hall. Palaeontology of New York. 1859. 3:215, pt 36, fig. 1, a–p
Rhynchospira globosa Hall & Clarke. Palaeontology of New York. 1894. v. 8, pt 2, p. 109

This species occurs, though not commonly, in the New Scotland beds of New York. Specimens from Cape Rosier Cove, lower beds, agree with New York examples.

Atrypina imbricata Hall

Leptocoelia imbricata Hall. Palaeontology of New York. 3:246, pl. 38, f. 8–13
Atrypina imbricata Hall & Clarke. *op. cit.* v. 8, pt 2, pl. 53, f. 5–10

This little shell is present at Cape Rosier Cove.

Atrypina sp.?

Plate 29, figure 18

We figure a specimen from the Grande Cavée showing the dorsal valve of a large and highly lamellose shell of the expression of A. imbricata of the Helderbergian fauna but without plications.

Nucleospira ventricosa Hall

Nucleospira ventricosa Hall. Palaeontology of New York. 1859. 3:220, pl. 14, fig. 1; pl. 28 b, fig. 2–9

Specimens of this Helderbergian species appear occasionally at Cape Rosier Cove.

Meristella laevis Vanuxem

Atrypa laevis Vanuxem. Geol. N. Y. 3d Dist. 1843. p. 120, fig. 2
Merista laevis Hall. Palaeontology of New York. 1859. v. 3, pl. 39, fig. 3, 4
Meristella laevis Hall & Clarke. Palaeontology of New York. 1894. v. 8, pt 2. pl. 43, fig. 3–6; pl. 44, fig. 4

This species from the Coeymans and New Scotland beds of Eastern New York, occurs rarely and in diminished size at Cape Rosier Cove.

Spirifer perlamellosus Hall (?)

cf. Spirifer perlamellosus Hall. Palaeontology of New York. 1859. 3:201 pl. 26, fig. 1, 2

Examples of these shells, so far as observed, bear but four ribs on each side of fold and sinus and are quite coarsely lamellose. For the most part they have a very high cardinal area though in this regard are not unlike some of the New York shells from the Helderbergian. The species at Dalhousie is less extreme in this respect.

Locality. Cape Rosier Cove, upper beds.

Stropheodonta patersoni precedens nov.

For description *see* p. 186

Tentatively a series of specimens from the St Alban beds is referred to this mutation.

Stropheodonta rosieri nov.

Plate 35, figures 1, 2

This is a small shell characterized by its simple, relatively coarse and highly angular plications which increase by implantation starting with 8–10 at the beak and becoming twice that number at the margin. Over these and in the intervals are fine radiating surface lines. The umbonal region is crenulated by undulating concentric lines which may sometimes extend over the whole surface. The shells have thus some of the characters of S. patersoni precedens of the Grande Grève limestones and of those known in the New York rocks as S. varistriata, but the divergence from either is apparently fixed.

Locality. Cape Rosier Cove, lower beds.

Leptostrophia magnifica Hall

Plate 39, figure 10

For description *see* p. 190

This species in full proportions is present in the lower beds of Cape Rosier Cove.

Leptostrophia becki Hall

Strophodonta beckii Hall. Palaeontology of New York. 1859. 3: 191, pl. 22, fig. 1, a–t

The representatives of this characteristic Helderberg species are small but sufficiently characteristic.

Locality. Grande Cavée of Griffon Cove river.

Leptaena rhomboidalis Wilckens

Plate 34, figures 1, 2

Strophomena rhomboidalis Billings. *op. cit.* p. 27

The specimens of this species are well characterized by the very steep anterior fold which carries a broad median depression and two or more broad radial undulations. In this and other respects the specimens are altogether of the type of the Helderbergian examples and are noticeably distinct from those of the higher beds.

Localities. At Cape Rosier Cove and also in the beds at the Grande Cavée.

Strophonella punctulifera Conrad (sp.)

Plate 37, figures 10, 11

Strophomena punctulifera Conrad. An. Rep't Palaeontology of New York, 1838. p. 117

St. euglypha Conrad *idem.* p. 36

Strophodonta punctulifera Hall. Palaeontology of New York. 1859. 3: 188, pl. 21, fig. 4; pl. 23, fig. 4–7

Strophodonta punctulifera Billings. Palaeozoic Fossils, *op. cit.* p. 30, pl. 3, fig. 2

Strophonella punctulifera Hall & Clarke. Palaeontology of New York. 1892. v. 8, pt 1, pl. 12, fig. 10–12

This well known Helderbergian species is quite common in the lower division of Cape Rosier Cove.

Strophonella leavenworthana Hall

Plate 37, figures 7-9

Strophodonta leavenworthana Hall. Palaeontology of New York. 1859. 3: 189, pl. 21, fig. 5–7; pl. 23, fig. 1–3

Strophonella leavenworthana Hall & Clarke. Palaeontology of New York. v. 8, p. 1, pl. 12, fig. 6–9

Specimens of this species are smaller than those of the New Scotland beds of New York but the latter are otherwise without variation from the type common at the Grande Cavée.

Orthothetes (Schuchertella) woolworthanus Hall (sp.)

Plate 41, figure 14

Strophomena woolworthana Hall. Palaeontology of New York. 1859. 3:192, pl. 17, fig. 1, 2

A characteristic species of the Helderbergian (New Scotland beds). Cape Rosier Cove, lower division.

Orthostrophia canadensis nov.

Plate 43, figures 5, 6

This singular genus which has been recognized only at the horizon of the Helderbergian fauna is represented by two described species, O. strophomenoides Hall (New York) and O. halli Safford (Perry county, Tenn.) That before us is smaller than these, the valves well characterized by the muscle scars peculiar to the genus. Their features in detail are as follows: The valves are subcircular with a straight hinge; in contour the ventral valve is the shallower but bears a high median ridge, while the deeper dorsal valve carries a broad and low median sinus. Inside, the ventral valve has the muscular area concentrated posteriorly into a single scar not more extensive than the single pedicle scar in more typical orthids; the dorsal valve has a thin erect cardinal process and four distinct adductor scars.

The surface is marked by radial striae of unequal size.

Localities. We have a ventral valve of this species from the Grande Cavée, and a dorsal valve from Cape Rosier Cove. This species is also known to occur in the Square Lake limestone of northern Maine.

Dalmanella subcarinata Hall

Orthis subcarinata Hall. Palaeontology of New York. 1859. 3:169, pl. 12, fig. 7–21

This species, very common in the New Scotland beds of Albany and Schoharie counties, is represented by thoroughly characteristic and typical specimens.

Locality. Cape Rosier Cove, lower beds.

Dalmanella cf. **discus** Hall

See Orthis discus Hall. Palaeontology of New York. 1859. 3:165, pl. 10a, fig. 7–12

A series of small subcircular and subconvex valves appears to agree with the typical expression of this species from the New Scotland beds.

Locality. Cape Rosier Cove, upper beds.

Pholidops ovatus Hall

Pholidops ovatus Hall. Palaeontology of New York. 1859. 3:490, pl. 103b, fig. 8

A Helderbergian species occasionally found in the lower beds at Cape Rosier Cove.

Dictyonema splendens Billings

Dictyonema splendens Billings. Palaeozoic Fossils. p. 12, fig. 2, 2a

Description.— Frond four or five inches in length and width; longitudinal stems about one-third of a line wide, and about their own width distant from each other. The connecting bars, or dissepiments, are very slender and fragile. They seem to vary in their distances, from half a line to three lines. It is probable that, when perfect, they are at a uniform distance of about half a line, and that when they are more remote some of the intermediate ones have not been preserved. The substance of the stipes is rough, black and shining, and apparently with some irregular longitudinal striae.

No cells or serrations can be seen in any of the specimens examined. There are five or six longitudinal stipes in the width of two lines. In the specimen above, fig. 2a, however, they are more distant, and this may represent a distinct species.

Locality and Formation.— Between Cape Gaspé and Cape Rosier. Gaspé limestone No. 1.

This species has been occasionally found by us at this locality and the same form occurs both in the Grande Grève formation and in the rocks of Stewarts Cove, Dalhousie.

Zaphrentis shumardi (M.-E. and H.) Lambe

Zaphrentis rugulata Billings. Palaeozoic Fossils. p. 8, pl. 1, fig. 3, 3a

Zaphrentis shumardi (Milne-Edwards and Haime) Lambe. Contributions to Canadian Palaeontology, v. 4, pt 2. 1901. p. 121

Zaphrentis rugulata was described from quite incomplete material presenting a rugose corallum with a deep cup and is said to have come from "Cape Gaspé, Gaspé limestone no. 1." As division 1 is not represented at Cape Gaspé we hesitate as to the proper construction of the age of the species. Such corals have not been observed by us.

Mr Lambe has examined the original specimen of Z. rugulata and regards it identical with that cited, which is from the Niagaran fauna.

Favosites helderbergiae Hall

Favosites helderbergiae Hall. Palaeontology of New York. 7:8, p. 4–6

Common at Cape Rosier Cove.

Favosites cf. gaspensis Lambe

See Favosites gaspensis Lambe. Contrib. Canadian Paleontology. v. 4. 1899. pt 1, p. 8

Mr Lambe has described this as a lobate or subdendroid species from the "Lower Helderberg" at l'Anse au Gascon on the Bay of Chaleur. Specimens from Cape Rosier Cove are in apparent agreement both in form and internal structure.

Alga

Plate 48, figures 6, 7

The specimen here illustrated from Cape Rosier Cove has been referred for examination to Mr David White of Washington, who has made this commentary thereupon.

"I am far from satisfied as to its systematic position. The suggestion of a direct genetic relation to Lepidodendron afforded by the carbonaceous residue of the axis and the position of the appendages is not sustained I believe by a close inspection under the lens. On the contrary I would urge a comparison of the algoid types represented in Plumalina, Bythograptus, Chaetomorpha, etc. At the low stage at which this fossil is found we must watch for the genesis of Lepidodendron from thickened (protoxylum elements) axes bearing broad based delicate leaves probably spirally developed from alternation in verticils. In this case the specimen, possibly on account of its preservation, will not warrant a reference to the Lepidodendroid group. It appears to be a more primitive and simpler type than Lepidodendron gaspianum, though I suspect that specimens of this kind are on record under the latter name."

Spirophyton

A form of this fucoid (?) similar to the S. cauda-galli Vanuxem, occurs at Cape Rosier Cove.

II FAUNA OF THE CAPE BON AMI BEDS

Cordania gasepiou nov.

For description *see* p. 136

This trilobite occurs with some small gastropods and Hindias in limestones at the Quay, Cape Rosier Cove.

Kionoceras cf. rhysum nov.

For description *see* p. 142

An annulated species which seems to be identical with that from the upper beds (Grande Grève limestone) occurs in the beds at the summit of

the King's road about the horizon of Logan's division 6 and also at the Grande Cavée.

Poleumita princessa Billings (sp.)

Plate 16, figures 9, 10

Pleurotomaria princessa Billings. Palaeozoic Fossils. p. 59, fig. 29

Description.— The only specimen of this species collected consists of the two last whorls. From these it would appear that the apical angle is about 80°. The transverse section of the whorls is nearly circular. On the upper margin of the whorls, next the suture, there is a band which is about two and one half lines wide at the aperture and becomes gradually narrower above. At its outer edge there is a narrow sharply elevated keel which may represent the respiratory band. Where it terminates there is a small notch in the lip. The remainder of the surface is ornamented by a number of spiral ridges, each less than half a line in width, and about a line distant from each other. As the whorls increase in size, new ridges are intercalated between the old. These are crossed by fine, sublamellose, vertical striae, four or five in the width of one line. In crossing the ridges the striae are all curved backwards.

The umbilicus, in this specimen, is concealed, and must be, judging from the form of the basal whorls, very small. The form of the apex is not clearly indicated, but it appears to have been much depressed, or nearly flat, as represented in the figure. It may be that this appearance is due to pressure, or the absence of the apical whorl.

Locality and Formation.— Between Cape Gaspé and Cape Rosier.

We have not found this species but present herewith new figures of the original.

Platyceras cf. **unguiforme** Hall

See Platyceras unguiforme Hall. Palaeontology of New York. 1859. 3 : 319, pl. 58, fig. 7

Some small deeply furrowed forms of Platyceras present rather close similarity to this species from the New Scotland beds of New York.

Locality. From the Quay, on Cape Rosier Cove; Logan's division 4.

Modiomorpha varia Billings (sp.)

Plate 22, figures 1-3

Modiolopsis varia Billings. Palaeozoic Fossils, p. 56, not figured

Description.— Sub-ovate, obliquely depressed convex from the umbones to the posterior part of the ventral margin, or to the lower part of the anterior margin. In the greater number of the specimens an obscure depression extends from the umbones to the ventral margin, causing a faint sinus about the middle, or a little in front thereof; umbones about one sixth or one fifth the length from the anterior extremity; beaks small and apparently incurved. Dorsal margin more or less elevated and compressed, nearly straight to a point a little behind the mid-length; then passing with a rounded or sub-angular curve into the anterior margin. Ventral margin gently convex, often nearly straight or slightly sinuated a little in front of the middle; somewhat abruptly curved up to the anterior angle, more broadly rounded, often obliquely truncated in the upper half or two thirds.

Surface with obscure concentric rings of growth, from half to two lines wide. These are also covered with very fine obscure concentric lines.

Length of the largest specimen seen, eighteen lines. The proportions vary greatly, as may be seen by the following measurements of three specimens:

	Length	Hight at umbones	Greatest hight
No. 1	14 lines	5 lines	10 lines
2	15 lines	8 lines	11 lines
3	14 lines	6 lines	12 lines

The form is also variable; the posterior margin being either broadly and nearly uniformly rounded or more or less distinctly angulated, usually a little below the middle.

Locality and Formation.— Between Cape Gaspé and Cape Rosier; Gaspé limestone, Lower Helderberg.

Billings did not figure this species but we have here given illustrations from his original material. The specimens are labelled as from Indian Cove and from "Grand to Little Portage."

Orbiculoidea bella Billings (sp.)

Plate 47, figures 17, 18

Crania bella Billings. Palaeozoic Fossils, v. 2, pt 1. 1874. p. 15, fig. 5

This shell, of which we figure the originals, is an Orbiculoidea.

Locality. Cape Bon Ami.

Leptaena rhomboidalis Wilckens

Lingula artemis Billings

See Billings. Palaeozoic Fossils, v. 2, pt 1. 1874. p. 14, fig. 4

Lingula lucretia Billings

See Billings. Palaeozoic Fossils, v. 2, pt 1. 1874. p. 14, fig. 3

Duncanella cf. **rudis** Girty

Duncanella rudis Girty. N. Y. State Geol. 14th Rep't. 1895. p. 299, pl. 2, fig. 7, 8

Cape Bon Ami beds at the Quay, Cape Rosier Cove, and in the New Scotland beds of the Helderbergian, N. Y.

Hindia fibrosa Roemer

See notice of this species under *Fauna of the Dalhousie formation.*

III FAUNA OF THE GRANDE GRÈVE LIMESTONES

ANNELIDA

Spirorbis latissimus nov.

Plate 11, figures 3, 4

Tube close coiled and appressed to the surface of attachment throughout growth. Expansion very rapid, umbilicus very narrow and final whorl broad and depressed. Surface smooth or with fine and regular concentric lines. Diameter 2 mm.

Locality. Grande Grève. Attached to Kionoceras rhysum and Dalmanites dolbeli.

Cornulites cingulatus Hall

Plate 11, figure 5

Cornulites cingulatus Hall. Palaeontology of New York. 1888. 7 : 20, pl. 116, fig. 29

Cornulites cingulatus Clarke. N. Y. State Mus. Mem. 3. 1900. p. 27, pl. 2, fig. 35–38

The specimens of this species at the Grande Grève show slight radiciform extensions of the rings about the cicatrix of attachment. The species was described from the Helderbergian (New Scotland beds) and also occurs in the Oriskany of Becraft mountain.

Autodetus beecheri Clarke

Plate 11, figures 1, 2

Autodetus beecheri Clarke. American Geologist. 1894. 13 : 334, fig. 17–19

Autodetus beecheri Clarke. N. Y. State Mus. Mem. 3. 1900. p. 26, pl. 2, fig. 27–29

This species, described from the Oriskany of New York, is found not infrequently in the beds at Grande Grève.

Tentaculites leclercqia nov.

Plate 12, figures 5-7

Shells having very much the configuration of Tentaculites gyracanthus Eaton,[1] occurring, like that, in aggregations in the limestone, but uniformly of very much greater size. The slender cones, attaining a length of 10–15 mm, are strongly annulated but the annuli are often highly irregular in size and have an abrupt or concave slope on the lower side and

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[1] See Hall, Palaeontology of New York. 1859. 3 : 137, pl. 6, fig. 22, 23 (*T. irregularis*); and *idem.* 1888. v. 7, suppl. pl. 104, fig. 7–13

a convex slope above. They are themselves covered with fine concentric elevated lines. The annuli appear to extend to the tip of the shell.

Locality. Abundant at Percé Rock.

Species name. Chrestien LeClercq, Recollet Missioner at Percé 1675 and author of the *Nouvelle Relation de la Gaspesie.*

Tentaculites elongatus Hall

Plate 12, figures 8, 9

Tentaculites elongatus Hall. Palaeontology of New York. 1859. 3:136, pl. 6, fig. 16–21

Tentaculites elongatus Clarke. N. Y. State Mus. Mem. 3. 1900. p. 27, pl. 3, fig. 8–12

To this well known species from the Helderberg and Oriskany faunas I assign a series of specimens from the limestones which bear the regular annulations with deep interspaces, the latter strongly and the former faintly marked by fine concentric lines. The Grande Grève specimens however are not so large as those of New York and they appear to taper somewhat more rapidly, but the specimens from Percé have normal dimensions.

Localities. Grande Grève and Percé Rock.

TRILOBITA

Phacops logani (Hall) Clarke

Plate 10, figures 1–4, 7–9

Phacops logani (Hall) Clarke. N. Y. State. Mus. Mem. 3. 1900. p. 21, pl. 1, fig. 1–5

cf. Phacops logani Hall. Palaeontology of New York. 1859. 3:353, pl. 73, f. 15–25

The species from the Oriskany of Becraft Mountain identified by the author with the Helderbergian form Phacops logani Hall, is well represented by the series of small cephala and pygidia found at Percé. There may be some slight distinction between these forms and typical P. logani, but if so it is very refined. The Percé cephala have a low glabella, sparsely tubercled but often quite clearly furrowed. They bear a minute spinule at the genal angles usually so faint as to be seen only on the internal cast; the internal cast also shows a row of knots along each dorsal furrow; they are without spine on the neck-ring. The pygidium has 4–5 flat, duplicate pleural ribs and 7–8 axial, the axis being short and blunt with its apex well removed from the margin.

Locality. Percé Rock; also in the St Alban beds on Griffon Cove river.

Phacops logani Hall var. **gaspensis** nov.

Plate 10, figures 5, 6, 10–16

The species of Phacops very common in the Grande Grève limestones presents itself in all variations of size. The larger forms are coarsely tubercled on the glabella and in these there is a well defined row of knobs on the thoracic axis along the dorsal furrows, shown always to best advantage on the internal cast. The pygidium has 4–5 duplicate lateral ribs. Added to these critical features is the absence of genal spinules. The larger of these forms have a close and distinct resemblance to the species described by Hall as Ph. bombifrons[1] from "the limestone of the Helderberg mountains," by which was intended that now known as the Onondaga limestone, a resemblance expressed in all the characters of the cephalon which carries a full bombate glabella. We have no means of knowing the other parts of the animals thus designated by Hall. In the Grande Grève rocks these large, coarsely tubercled cephala have the thoracic segments knotted at the dorsal furrows as in large specimens of P. logani. In smaller specimens these thoracic characters are obscured except in the cast, but the cephalic shields of the latter do not show the spinules of the Percè species and of typical P. logani.

The variations of expression in the representatives of the genus Phacops in the New York Devonic are slender and identifications are always obscure. Fixing upon the following characters as critical, viz., the cristation of the genal angles, the knotting of the thoracic segments along the dorsal furrows and the grooving of the pleural ribs on the pygidium, we may tabulate the species thus:

	Cheeks	*Thorax*	*Pygidial ribs*
P. logani (Helderbergian)	faintly spined	knotted	duplicate
P. cristatus (Schoharie grit)	strongly spined	smooth	duplicate
P. cristatus var. pipa (Onondaga)	faintly spined	smooth	duplicate
P. bombifrons (Onondaga)	smooth	smooth	duplicate
P. rana (Hamilton-Ithaca)	smooth	smooth	simple

In this schedule the Grande Grève species takes a place close to P. logani; the Percé form, which is always small, is a nearer approach to the typical expression of the species.

Localities. Everywhere along the Forillon from Shiphead to Little Gaspé, and in the blocks of limestone from the second range found in the stream bed at Peninsula. Also at the Ruisseau du Grande Cavée associated with *Dalmanites griffoni.*

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[1] Descriptions of New Species of Fossils. 1861. p. 67; N. Y. State Cab. Nat. Hist. 15th An. Rep't. 1862. p. 95; Illustrations of Devonian Fossils. 1876. pl. 6, fig. 22–24, 29.

Dalmanites micrurus Green (sp.)

Plate 9, figures 1-3

Asaphus micrurus Green. Monogr. Trilobites N. Am. 1832. p. 56, fig. 3
Dalmania micrurus Hall. Palaeontology of New York. 1859. 3 : 359, pl. 74, fig. 13-20
Dalmania pleuroptyx Hall (not Green). *Idem.* pl. 74, fig. 1-6, 9-12
Dalmanites micrurus Hall & Clarke. Palaeontology of New York. 1888. 7 : 29

The original specimens of Green's species Asaphus micrurus and A. pleuroptyx, both of which are in the State Museum, are pygidia. The former name was applied to a large tail[1] which the author thought was from the Trenton limestone, though Hall corrected this error with the aid of the accompanying fossils in the matrix of the specimen. It is plainly from the Helderbergian Coeymans limestone, probably of the Schoharie valley. The original of the latter species, D. pleuroptyx, is a small pygidium from the New Scotland beds of the Helderberg. In later collections we have found that this style of pygidium is that prevailing in the Helderbergian and appertains to the type of cephalic structure illustrated in Palaeontology of New York, v. 7, pl. 11A, fig. 1, under the name D. pleuroptyx. When Hall was describing the Helderbergian trilobites (Pal. N. Y., v. 3) chiefly from material gathered in the Schoharie valley, he allocated to the D. pleuroptyx tail a very different style of cephalon, namely that now ascribed by us to D. micrurus. He had then but a single and extremely young entire individual of this type wherein it was practically impossible to tell which species the pygidial characters indicated, and it is a singular fact that notwithstanding the abundance of these Helderbergian remains, the one (D. micrurus) in the Coeymans and the other (D. pleuroptyx) in the New Scotland beds, but a single entire specimen of each is known to us. As the original tail of D. pleuroptyx is from the New Scotland beds and we know the rest of the test structure it follows that all the cephala referred by Hall [*op. cit.*] to that species, as they are of a distinct type of structure and as these two species are the only Dalmanites known from the Helderbergian fauna, belong to the species D. micrurus.

Such cephala we have from the Grande Grève limestones. The type of structure presented therein is notable for two features, (1) entire independence of the lateral glabellar lobes, (2) absence of ornament on the frontal border. The outline is regularly semielliptical with rather short genal spines. The surface is moderately elevated with abrupt slopes beneath the eyes. The dorsal furrows are deep where they border the

[1] Green, regarding the pygidium as "tail and abdomen," gave the name "micrurus" on account of the small caudal spine.

frontal lobe and specially on the anterior half of the limb. Frontal lobe large, transversely subrhomboidal; the other three pairs of lobes distinctly separated. Eyes large with grooved bases, sutural furrow on the cheek deep and smooth. Frontal border moderately broad, slightly concave, smooth and entire. This type of cephalon conforms closely to that of D. hausmanni which stands as the type of the subgenus Hausmannia Hall & Clarke, probably equivalent to Odontochile. It is an archaic type in the sense that it prevails in the late Siluric, nearly all fully developed Devonic Dalmanites except Cryphaeus showing a fusion of adjoining lateral lobes, which is distinct in character from the lobal fusion present in Chasmops, Monorachus and Pterygometopus of the Lower Siluric. In minor differentials there is no distinction between the Grande Grève specimens and the cephalon of this species as found in the Coeymans limestone, save that in the former the median depression on the frontal lobe is more pronounced, the granulation is coarser and on the cheeks the granules show a tendency to fusion.

Dimensions. Axial length 24 mm; width across the base 47 mm.

There are some small pygidia which have the general type of that of D. micrurus, agreeing therewith in form and in the character of the flattened faintly grooved ribs and in the short caudal spine. The original of this species has 14–15 lateral ribs and 15–16 axial, while the Grande Grève specimens have but 10 lateral and 13–14 axial. If these tail shields actually belong to the cephalon described they indicate a slight variation from the New York type. Among these shields themselves there is apparently some slight difference in the length of the caudal spine.

Localities. From the middle horizon of the limestone near Indian Cove and Lehuquet's Cove.

Dalmanites dolbeli nov.

Plate 8, figures 1–7

cf. Dalmanites pleuroptyx Logan. Geol. Can. 1863. p. 393

Certain cephala and pygidia of these beds which there are good reasons for assigning to each other present many points of resemblance to several well known species of the same subgeneric type. The latter are D. pleuroptyx of the New Scotland beds (Helderbergian), D. stemmatus of the Oriskany and D. anchiops of the Schoharie grit. Generally speaking these four species are alike in the following respects: They are all forms which attain a large size, have notably short and broad cephala, with the first and second glabellar lobes fused distally and elevated to the eye lobe, frontal border with a row of crenulations at the edge, the more conspicuous being terminal, grooved eye base, faint if any groove along the lateral facial suture, and inosculating surface markings on the cheeks. The tails are broadly triangular and sparse ribbed ending in caridal spines not greatly extended.

By tabulating the differentials of these four species we shall indicate the features in which the Grande Grève form is unlike the rest.

	pleuroptyx	stemmatus	anchiops	dolbeli
cephalon	short	longer	short	short
occipital ring	no spine	no spine	spine	no spine
confluent papillae on cheeks	conspicuous	inconspicuous	inconspicuous	inconspicuous
suture line on cheek	flush	flush	depressed	flush
pygidium lateral ribs	11–13	9–10	8–9	8–9
axial ribs	13–(15)	9–(11)	9–(14)	10–(13)
ribs	deeply grooved, rounded	not grooved, rounded	not grooved, rounded	faintly grooved, rounded
caudal spine	short, acute, elevated axially	broad, obtuse, not elevated axially	slender, extended, upturned, not elevated axially	broad, somewhat extended, upturned, blunt, and not elevated axially

Sharing its principal structures with the other three and separated from them by differentials which are of the same quality as those distinguishing other members of the series, D. dolbeli represents a notably early Devonic type of structure.

Dimensions. Cephalon; large examples attain an axial length of 40 mm and a width of 75 mm. Pygidium: An average example has a length of 40 mm and a width of 60 mm.

Localities. In the middle beds at Grande Grève and in the greenish sandy beds 50 feet below the chert at Shiphead.

Species name. A. H. Dolbel, of the William Fruing Co. Lt., the leading fishing establishment on the Forillon.

Dalmanites lowi nov.

Plate 9, figures 6–8

A very distinct type of structure is presented by a few pygidia which are of considerable size, relatively quite short, broad at the top, with pleural

ribs 10 or 11 in number, the last three of which are simple and faint but all the rest very strongly duplicate throughout their entire extent, becoming obsolete at or just within the margin. The axis is broad and the dorsal furrows rapidly approximate; it bears 11 or 12 segments and its apex is not abrupt but merges into a low median ridge continued to the end of the tail. The terminal spine is little more than a broad and short rather obtuse expansion. The surface of the test is finely granulate except for a few scattered coarser pustules on the axis. The specimens average 26 mm in length and 29 mm in width.

This style of pygidial structure with strongly bifurcate pleural ribs is freely represented in the faunas of the early Devonic elsewhere by such species as D. bisignatus Clarke and D. dentatus Barrett (Oriskany), D. veiti and D. phacoptyx. Dalmanites dentatus, its associate D. dolphi Clarke and D. veiti are known to have a crenulated or dentate border but D. phacoptyx is without this feature.

Localities. Grande Grève and Indian Cove.

Species name. A. P. Low, Director of the Geological Survey of Canada and early worker in Gaspé geology.

Dalmanites phacoptyx Hall & Clarke

Plate 7, figures 5–10

Dalmanites phacoptyx Hall & Clarke. Palaeontology of New York. 1888. 7:31, pl. 9, fig. 23–27

Dalmanites phacoptyx Clarke. Mem. 3. N. Y. State Museum. 1900. p. 19, pl. 2, fig. 10

This species was based upon a series of large, coarsely tubercled and echinate but incomplete pygidia, having a slender but extended tail spine. The original specimen was from the so-called Onondaga limestone at North Cayuga, Ontario, an horizon which is now recognized as included in the beds termed by Schuchert the Decewville formation and whose fauna is a commixture of Oriskany and Onondaga species.

Dalmanites phacoptyx. A portion of the cranidium and cheek spine, showing the spinules on both. From the slab represented on the adjoining plate

Among the commoner specimens in the Grande Grève limestone are pygidia of this type. These are broadly triangular plates of nearly equal length on the three sides, gently and regularly convex with relatively narrow and slender axis. The pleural ribs are grooved but this duplication

is much less sharply defined on the surface of the test than on the cast. There are 12–14 of these lateral ribs and 13–16 segments on the axis. The caudal spine is about 15 mm long and quite slender, usually absent in ordinary preservation. These shields, agreeing in all essential details of structure with the originals, are accompanied by parts of cephala which enable us to complete in a measure our knowledge of the species. These are of a size to correspond with the pygidia; the glabella is normally lobed with a tendency to coalescence of the first and second lateral lobes (Synphoria); the border appears to have been broad, smooth and uninterrupted; the surface is very coarsely tubercled and the frontal lobe of the glabella bears a single pair of elevated blunt spinules symmetrically placed with reference to the median axis. A spinule of like character lies at the middle of the nuchal ring. The suture lines are sunk in deep grooves; the eye greatly elevated, of magnificent proportions, bearing not less than 500 lenses; its base deeply and narrowly furrowed. The genal spine is broad, flat, finely pustulose and spined on its inner edge.

This is the largest of the Dalmanites in this fauna and almost attains the dimensions of D. perceensis to which species it is allied in many features.

Localities. From various spots in the upper strata about Grande Grève and thence toward Little Gaspé, also at Lehuquet's Cove and on the lower layers at Shiphead. Loose at Peninsula, washed down from the westward extension of these limestones.

Dalmanites veiti nov.

Associated with specimens of D. phacoptyx from the limestone hills behind Peninsula, Gaspé Bay, are abundant pygidia and cephala of uniform size, unlike the species with which they are associated as well as with any others of our acquaintance. These pygidia are relatively small, subequally triangular, flattened above and rather abruptly sloping at the margins; apparently without tail spine. There are 11–12 lateral ribs, 6 or 7 of which are grooved medially. The axis bears 13–14 segments. The upper limb of each of the divided lateral ribs carries 2, 3 or 4 pustules so developed as to overhang the sulcus, while each segment of the axis bears a single row of 5, 6

Dalmanites veiti. The underside of the cephalic doublure x2 and three pygidia natural size

A slab of Grande Grève limestone largely composed of trilobite remains most conspicuous among which are the head and tail shields of Dalmanites phacoptyx. Portions of two of these pygidia have been roughly restored in plaster. The smaller Dalmanites heads and tails are of D. veiti. This specimen was found loose on the hills behind Peninsula and was presented by Samuel Veit Esq. of Gaspé Basin

or 7 pustules. The length of these shields will average 23 mm with an anterior width of 29 mm.

The cephala belonging to these pygidia are not completely preserved but indicate a type of simple glabellar lobation as in D. micrurus, with closely pustulose surface. The border is smooth laterally but in front is extended into a short crenulated snout or shelf as in D. pleuroptyx and D. dolbeli though less expanded at the sides than in either of these.

There is undeniable similarity between this fossil and the D. bisignatus described by me from the Oriskany of Becraft mountain.[1] The latter, known only from the pygidium, has the part narrower and more elongate and its axial pustules are so arranged as to make a longitudinal median double row. That species we have noted (*op. cit.*) is allied to D. dentatus Barrett from the same horizon in Orange county N. Y. but in ignorance of the cephalon of the former, comparison can go no farther. Dalmanites veiti has a type of cephalon quite unlike that of D. dentatus which is dentate on the entire periphery.

Locality. This species has been found only in a loose block from the limestone ridge behind Peninsula, Gaspé Basin, in association with D. phacoptyx, Phacops logani gaspensis, Platyceras conulus, Anoplia nucleata and other species of the Grande Grève fauna.

Species name. Samuel Veit, Esq. of Gaspé Basin to whom I am indebted for the striking specimen here illustrated.

Dalmanites whiteavesi nov.

Plate 8, figures 11, 13

This species is represented by a series of small pygidia somewhat of the type of that part in D. anchiops but more particularly like that of D. meeki, figures of which may be found in Walcott's *Palaeontology of the Eureka District*, 1884, pl. 17, fig. 5 and *Palaeontology of New York*, 1888, v. 7, pl. 11A, fig. 29, 30; that is, rather short and subtriangular but with rounded margins and an extended, slender caudal spine. The axis is moderately broad and convex bearing 7 or 8 segments which are well rounded and the pleural ribs are of the same number, flat on top with narrow intervals and each is grooved by a fine line.

The margins of the shield curve slightly outward uniting behind to form a spine which has about one fourth the length of the shield. It is narrow, ends acutely and is slightly upturned. As a whole the shield is shorter, relatively broader and has more segments than does D. meeki. The latter is from the lower part of the Devonic series in Nevada.

Locality. Grande Grève.

Species name. Dr J. F. Whiteaves, Paleontologist of the Geological Survey of Canada.

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[1] Mem. 3. N. Y. State Mus. p. 19, pl. 2, fig. 6–8.

Dalmanites perceensis nov.

Plate 4, figures 1–3, plate 5, figure 2

The parts found of this species are separated pygidia and cranidia. In the latter the frontal lobe is gently rounded and depressed; the first and second lateral lobes well fused at their extremities; the surface of the frontal lobe coarsely papillose. The pygidium is broadly triangular, but little arched at the sides, the lateral margins rounding in full curves and the tail spine short, acute and upturned; the axis has straight regularly converging dorsal furrows and its width is less than two thirds the width of each pleura. It bears 18–20 broad flat directly transverse annulations with very narrow furrows. The fourth and eighth annulations bear two strong nodes on the axis and others on the ninth, twelfth and thirteenth show fainter traces of them. The broad and flat pleurae bear 15–17 flat ribs grooved by narrow and sharply incised oblique furrows; the ribs bend abruptly backward near the margin and are discernible almost to the edge of the shield. They are also sparsely but very irregularly nodose, the nodes being large and coarse. The whole surface is finely granular.

The dimensions of this species are impressive. A cranidium measures from the occipital ring to the anterior suture 70 mm and across the frontal lobe 60 mm, corresponding to an entire animal, having a length of about 11 inches. One entire pygidium measures 102 mm in length and 144 mm across the anterior margin. This, however, does not express the full size attained by the creature.

Among the imperfect pygidia is one retaining a part of the axis and of one pleura. The 6th axial segment from the top of the specimen (it is not clear that this is the upper margin of the pygidium) has a length (width) of 35 mm. Comparison with other pygidia of this species shows that a shield with a length of 25 mm has a 6th axial segment 5.5 mm long and in this proportion the length of the large pygidium would have been 159 mm or 6¼ inches. Considering the relation of the parts in species of this type we find that a pygidial length of 6¼ inches implies a total length of about 25 inches. This would be by far the largest Dalmanites yet recorded. The writer has noted the great size attained by another species of this genus Dal. (Coronura) myrmecophorus Green from the Onondaga limestone of the Appalachian gulf [Pal. N. Y. v. 7, pl. 15] and a restoration from a large pygidium gave a total length of 16¼ inches. This restoration was made with due consideration to variation in proportion of the parts in the various groups of the genus in both Coronura and Probolium, the cephalon being relatively short. If these figures indicating the size attained by Dalmanites perceensis are approximate there is but one trilobite known whose parts indicate still larger proportions, the mag-

nificent Uralichas ribeiroi Delgado, originally described from the Lower Siluric of the Vallongo basin in Portugal and subsequently found in the Angers schists of Western France as announced by Oehlert.[1]

The latter writer attempting a reconstruction of the entire animal, concludes that it attained a length of about 70 cm or 27½ inches. The great tail spine on this magnificent species which in a pygidium figured by Oehlert is not less than 6½ inches long, adds greatly to the actual length of the tergum. Aside from this, it is likely that the former attained the greater size; at all events the Percé species makes an interesting addition to the ranks of great trilobites which were specially predominant at this early Devonic stage: Homalonotus major of the Oriskany, H. colossus Lake, of the Bokkeveldt beds of South Africa, Dalmanites myrmecophorus of the Onondaga limestone, Terataspis grandis of the Schoharie grit and Onondaga limestone, D. anchiops of the Schoharie grit and D. tridens of the Helderbergian.

Locality. Found only in the Percé Rock.

Dalmanites emarginatus Hall

Plate 7, figures 2, 3

Dalmanites emarginatus Hall. Illustration of Devonian Fossils. 1876. pl. 10, fig. 2

Dalmanites (Coronura?) emarginatus Hall & Clarke. Palaeontology of New York. 1888. 7:40, pl. 11A, fig. 7, 8

When this species was described our knowledge of it rested solely on two small and like fragments of the posterior extremity of the pygidium, both displaying the emarginate posterior border and the tubercled ribs. These were both from the Schoharie grit of Schoharie, N. Y. The characters presented indicated a departure from the structure of the Dalmanites pygidium toward that of species subsumed under the generic term Coronura (Dal. myrmecophorus Green and D. diurus Green) in which the emarginate terminus is raised into an erect collar, from which simple and compound spines extend backward. The New York rocks have afforded no additional knowledge of Dalmanites emarginatus and it is thus interesting to find this species present, so far as we can judge from agreement in pygidial structure, and better presented in the Grande Grève limestones. We have some nearly entire pygidia of large size, broadly subtriangular in outline with narrow and spineless border, retreating at the posterior extremity in a broad curve to the apex of the axis. The pleurae

[1] See Delgado, Descripcão de uma forma nova de Trilobite, Lichas (Uralichas) Ribeiroi, 1892; Direccao dos Trabalhos Geolog. de Portugal; and Fauna Silurica de Portugal; Novas observacoes acerca de Lichas (Uralichas) Ribeiroi, Lisbon, 1897; also Oehlert, Uralichas ribeiroi des Schistes d'Angers; Memoires de la Soc. Géol. de France, 1896, no. 16, 2.

are broad, each being nearly two-fifths the width of the shield, and each bearing 15–16 rather narrow ribs separated by deep grooves, each rib divided by a sharply incised furrow. Each branch of the rib bears a row of irregular tubercles which are generally larger on the lower moiety and are retrally directed. These do not attain great size nor spread over the grooves and furrows as in some species. On the axis 16–17 flat annulations are present and these are also tubercled in a single row. Beyond the last apparent annulation is a smooth apical projection of the axis, present also in the originals of D. emarginatus. Our specimens indicate a length of 45 mm and a width of 70 mm.

Locality. Shore at Grande Grève and thence to Little Gaspé.

Dalmanites gaveyi nov.

Plate 8, figures 8, 9

Among the Dalmanites of these rocks, some with the snouted front of Probolium, others with the crenulated anterior margin of D. anchiops and D. pleuroptyx, and some having a smooth cephalic border (D. micrurus and D. phacoptychoides), we are presented with a species in which the frontal margin of the head bears a slight, simple, lobed and blunt extension without accessory processes or crenulations similar in effect to that of D. griffoni. This is a structure after the type of D. vigilans Hall and D. limulurus Conrad of the Niagara, of which a simple, well-lobed glabella is an accompaniment.

This species has been observed in several examples, has a rather short cephalon in which the glabella is subpentagonal, the dorsal furrows not deep and rather obscure at the outer ends, the frontal lobe highly transverse, right short, and merging directly into the frontal extension. The glabellar furrows are very obscure, the first and second lobes but illy defined, slightly swollen and club-shaped but the third lobes are linear and are better defined. Eyes comparatively small and not sulcate at the base, cheek spines very narrow and produced. The cheeks slope somewhat abruptly to a thickened and rounded edge without border. The surface is marked by no noticeable pustules but by a fine granular ornament. This is a very distinctive and rather rare type of structure expressed not so much in the frontal projection as in the somewhat swollen aspect of the glabeller lobes and the obsolescence of the furrows, as well as the smoothness of the surface. I should bring it into comparison with my D. galea from the Lower Devonic (Maecurú) sandstone of the Amazons wherein these characters are pronounced.

Dimensions. Length 12 mm, width 23 mm. One of the specimens carries a considerable part of the thorax but the pygidium of this species is not yet identified; it may prove to be that described as D. vatinius

or that figured on plate 8 and referred to previously as possibly pertaining to D. micrurus, though differing from those associated with cephala of the latter at the Grande Cavè and Dalhousie.

Locality. Between Grande Grève and Little Gaspé.

Species name. Daniel Gavey of Grande Grève.

Dalmanites (Probolium) biardi nov.

Plate 6, figures 1–12

Phacops weaveri? Salter. Silurian Trilobites. 1864. p. 57, fig. 15

There are two species of Dalmanites at Percé, one of them, the more common and that now described, a representative of the rare group of snouted forms to which Oehlert has applied the term Probolium[1] and which is exemplified by D. nasutus Conrad and D. tridens Hall of the Helderbergian of New York. This species has these characters.

Cephalon broadly subelliptical in outline, short axially, like the prevailing type in contemporaneous faunas (D. anchiops, pleuroptyx, stemmatus, nasutus, tridens). Glabellar division normal but the usual fusion of lobes 1 and 2 at their distal extremities which affects so many of the early Devonic species of Dalmanites, is not strongly expressed and herein again there is agreement with D. (Probolium) nasutus and tridens. Margin entire except near the anterior extremity where there is a series of broad low scallops or crenulations, 3 or 4 in number on each side of the snout. These are so obscure that they are seldom seen except on casts of the ventral surface of the border and in such cases the outermost sometimes assumes the aspect of a pair of subsidiary spines. The snout is axial, has a broad base, is contracted in diameter medially and at the distal extremity carries a trident the central process being axial, the other two diverging palmately and all considerably extended. There seems to be some variation in the length of this process but apparently it was from one third to one half as long as the cephalon itself. The entire process is flat. In the trilobed species of the New Scotland beds, D. tridens, there is likewise noticeable variation in respect to the development of these processes as shown by the figures given in *Palaeontology of New York*, v. 3, 1859, pl. 75, fig. 3–6. A very fine specimen collected by the late C. E. Beecher from these beds in the vicinity of Clarksville, has these processes so much reduced that the extremity takes on a spatulate outline. (See plate 5, fig. 1.) The genal spines are relatively broad and short. The surface of the cheek below the visual area is deeply grooved, the facial suture on the cheeks does not lie in a furrow and the surface below the eyes shows only rather obscure traces of confluent papillae. The general surface is

[1] Bull. de la Sociètè Gèol. de France, 3 ser. 1889. 17 : 759.

rather finely pustulose especially on the cheek spines. The thoracic segments show no features that can be regarded as distinctive.

Pygidium. Elongate, subequally triangular, subacuminate, of the general type of D. micrurus and less like the nodose surface with long tail spine characterizing D. (Probolium) nasutus. Axis relatively narrow, segments 10–12. Pleural ribs 9–10, flat above, grooved by a fine line and separated from each other by rather narrow furrows. Caudal termination a broad and short, acute and slightly upturned spine. Surface finely granulose on the ribs and along the margins with obscure evidence of low faint nodes.

Dimensions. The average of our specimens indicates a length of cephalon not including the snout, of 30 mm, a width of 63 mm. In such a specimen the snout would have a length of 16 mm with a spread from tip to tip of the lateral spines of 12 mm. An average pygidium measures 36 mm in length and 42 mm in width.

We refer above to Salter's assignment of this species to his Phacops weaveri which is a Siluric form from the May Hill sandstone. He has given a wood cut of a cephalon evidently incomplete at the proboscis of which he says in footnote. "I have good reason to believe this Canadian species brought by Sir W. Logan from Ile Percé, Gaspé, Lower Canada, to be identical with ours. The tail is a little more mucronate. The head agrees nearly with our fragments, and will at all events give collectors a good idea of the probable shape. It is remarkably triangular even for this subgenus" [Odontochile].

Though parts of this species are quite abundantly diffused through the rocks, entire examples have proven uncommon. One individual too incomplete for illustration affords a total length of 3½ inches with a greatest diameter of 1⅜ inches. The parts will not be confused with the larger species here present, D. perceensis, on account of absence of nodes on the pygidium and the much less degree of annulation which is a persistent feature in all the specimens examined.

Locality. Percé Rock and Blowhole Cliffs.

Species name. Charles Biard of Percé, to whose appreciative helpfulness in my work I owe much.

Dalmanites (Probolium) esnoufi, nov.

Plate 9, figure 5

A quite imperfect cephalon is the only representative thus far found in the Grande Grève rocks of the Probolium type of structure. In its general features it has the aspect of the shields which are here referred to D. micrurus, the border being broad, flat and smooth at the edge, the frontal lobe of the glabella transverse and rather narrow, the other lobes

quite small but the first two lobes are fused at the outer edges. The genal spines are produced, the eyes furrowed at their base and the groove within the border is conspicuous. The border in front is produced into a bifurcate process, the branches of which are flat, very divergent and rise from a broad base. We have noted that one of the specimens of the Percé species, Probolium biardi shows, probably by accident only two instead of the normal three branches of the snout but this difference is unaccompanied by any other structural departure in the shields and it has been observed but once. The aspect of the cephalon before us is very unlike that in the various details referred to. Dalmanites (P.) nasutus Conrad[1] is a bifurcate species in the Helderbergian (New Scotland beds) of New York, which has more in common with P. esnoufi, specially in its smooth border, but the base of its snout is very much more elongated and its branches slender and cylindrical. Though as yet we know but little of P. esnoufi, its presence here is of very great interest. The specimen measures in length, from tip of snout 32 mm, from front of glabella 23 mm and in width 50 mm.

Locality. In the cherty beds of the series between Grande Grève and Little Gaspé.

Species name. Esnouf, a well known Jersey surname on the Forillon.

OBSERVATIONS ON THE DALMANITES OF THE EARLY DEVONIC

No feature is more significant of the early stages of boreal Devonic faunas than the decline of Dalmanites expressed in concomitant development of cuticular excrescences. We have here portrayed a number of illustrations of these evidences of race debility and their occurrence is widespread. Subgeneric divisions have been founded on them and though these must, by the nature of the case, be of fugitive value yet they serve a purpose in efforts at correlation. These excrescential developments affect the head and tail shields chiefly, that is the stable or unmovable parts in contrast to the mobile parts of the thorax. It is to be noted that such modifications do not involve these parts in equal degree for a species with ornamented cephalic integument usually has the pygidium devoid of such traits; and the converse is quite as true. Species of Probolium, for example, in which the anterior border is produced into a long proboscis have a simple tail shield with a longer or shorter axial spine; on the other hand the genus Coronura, in which the tail is grotesquely ornamented in such form that the posterior extremity is divided and turned up into an erect collar prolonged into spines, has a cephalon with no dermal extravagances and quite in keeping with the typical expression of the Lower Siluric representatives of the genus.

We may observe that the accession of these dermal excesses accompanies the final appearance of other trilobite genera, but nowhere with such

[1] Palaeontology of New York, 3 : 362, pl. 76, fig. 1–8.

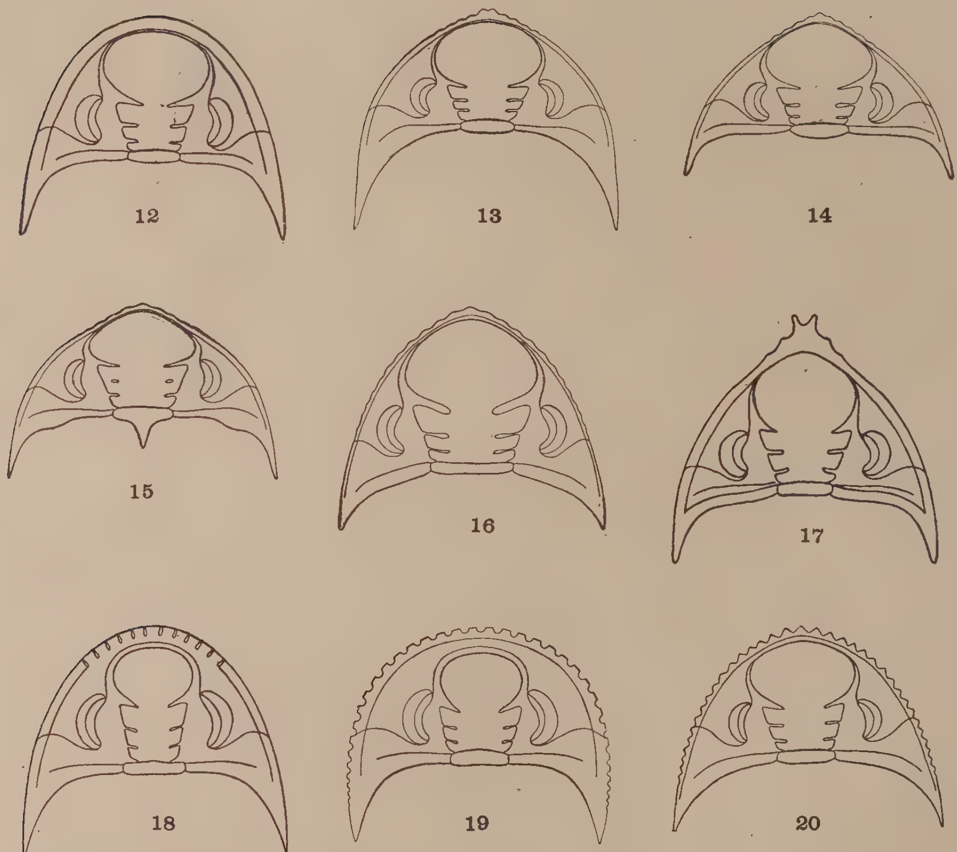
a profusion of illustration as presented by the genus Dalmanites. Yet no greater extreme is reached than in the species of Lichas we have here described, Gaspelichas forillonia, indeed the most extravagant instance of the development of spines among the trilobites. The early Devonic forms of Homalonotus often become echinate and even the genus Phacops, the most compact and conservative expression of all the *Phacopidae*, which in boreal faunas of this time occasionally assumes spinules on the genal angles and on the thorax, in austral faunas may put on a row of spines about the margin of the head. (P. dagincourti Ulrich, Bolivia.)

In Dalmanites the modification of the head shield is distinctly earlier than similar adornment of the tail. Cryphaeus and Coronura are forms with pygidial modification in which the tail furnishes the generic characters and these do not appertain to the earliest Devonic faunas. No species of the Helderberg-Oriskany or of those faunas we are here describing present any of these integumental modifications upon the tail. The tail shield has conserved the type better and is the last to be affected. These changes have not always progressed with equal foot. There are conservative species of Dalmanites that continue the generic type without modification into the early Devonic, the forms of Hausmannia or Odontochile, and it is these that have prolonged the existence of the type. In the following series of diagrams we have given expression to these variations and their time relations.

The variation in cephalic ornament indicated in these sketches is seldom accompanied by corresponding variation in the tail. Almost without exception the species whose cephala are here figured have tails of the simple triangular type, variation being manifest only in the degree of development of the caudal spine. In two rather widely separated types of frontal development, D. longicaudatus and D. nasutus, a very long caudal spine is present; Odontocephalus has a double tail spine (selenurus) and Cryphaeus with a simply lobed head, as in figure 1, has a fringe of five flat leaf-shaped pleural lobes on each side and one axial. Otherwise the pygidia are of practically the same expression and in no correspondence with the variations of the cephalon.

Dalmanites. A series of cephala showing the variation in the frontal border from the normal type, Hausmannia or Odontochile, to the Probolium condition.

1 Hausmannia (Odontochile) with smooth border and complete glabellar lobation; late Siluric and early Devonic. 2 D. gaveyi, with short, angular frontal projection; early Devonic, Grande Grève limestone. 3 D. griffoni, with spatulate snout; early Devonic, St Alban beds. 4 D. longicaudatus Salter, with narrow prorate snout (Wenlock). 5 D. (Probolium) beyrichi Kayser; early Devonic, Hartz. 6 D. (Probolium) galloisi Oehlert; early Devonic, Angers. 7 D. (P.) nasutus Conrad, with extended bifurcate snout; early Devonic, Helderbergian, N. Y. 8 D. (P.) esnoufi, in which the trunk of the bifurcate snout is suppressed; early Devonic, Grande Grève limestone. 9 D. (P.) tridens Hall, with produced snout having a spatulate trifid extremity; early Devonic, Helderbergian, N. Y. 10 *Idem.* The usual trifid type of extremity. 11 D. (P.) biardi, with short, deeply trifid snout and crenulated antelateral limbus; early Devonic, Percé.



Dalmanites. A series of cephala indicating stages of development in the border to a condition of complete crenulation.

12 Dalmanites (Hausmannia) micrurus Green; early Devonic, Helderbergian, N. Y. 13 D. pleuroptyx, Green; early Devonic, Helderbergian, N. Y. 14 D. dolbeli, early Devonic, Grande Grève limestones. 15 D. anchiops, Green var. armatus Hall; early Devonic, Schoharie grit, N. Y. 16 D. stemmatus Clarke; early Devonic, Oriskany limestone, N. Y. 17. D. dolphi Clarke. Here is a departure toward the Probolium condition with crenulated border [see p. 133, fig. 11]; early Devonic, Oriskany limestone, N. Y. 18 D. (Odontocephalus) selenurus Conrad. Indentations of the border deep, the denticulations flat, incisor shaped, in contact at the periphery but not coherent. Early Middle Devonic, Onondaga limestone, N. Y. 19 D. (Corycephalus) regalis Hall; early Devonic, Schoharie grit, N. Y. 20 D. dentatus, Barrett; early Devonic, Oriskany limestone, N. Y.

Proetus phocion Billings

(= Proetus conradi Hall?)

Plate 9, figures 14–16

Proetus phocion Billings. Palaeozoic Fossils v. 2, pt 1. 1874. p. 63, fig. 31
Proetus phocion Hall & Clarke. Palaeontology of New York. 1888. 7:125, pl. 25, fig. 9–10

This species, common in the Grande Grève limestone, was described from an internal cast of an entire individual and this specimen was redrawn by Hall and Clarke and another enrolled individual figured with it. Our material has not afforded any specimens as good as those, hence we have here reproduced the drawings given in the last cited work.

The original description was as follows:

Description. Oblong-ovate; both extremities uniformly rounded, the pygidium more broadly so than the head; sides of the thorax parallel. The head is rather strongly convex, semi-elliptical; its length a little greater than half its width at the base; front smoothly rounded; sides gently curved; posterior angles with very short spines. The marginal border is well developed; it has a shallow median groove which is most distinct around the front, and down the sides, but dies out on approaching the posterior angles of the head; the border is separated from the cheeks by a distinct groove, which runs all around the sides and front of the head, touching the front of the glabella in specimens with the crust preserved. When the crust is not preserved, the front of the glabella, as seen in the cast, does not quite reach the cast of the groove. Glabella regularly conical, about one seventh shorter than the head, convex, most elevated between the eyes. There are indications of glabellar furrows, but they are too indistinctly seen in the specimens to be located with certainty. Neck-furrow crossing the glabella, very nearly on (but a little behind) a line connecting the posterior corners of the eyes. It is nearly straight for about one half of its length in the middle, and then turns forward, slightly, at each end to the eye. The neck-segment has a small tubercle in the middle and at each end is partially cut off, by a short groove which extends downwards and outwards from the neck-furrow; the part above the groove having somewhat the appearance of a large triangular tubercle. Eyes large, semi-circular, in contact with the sides of the glabella.

Thorax of ten segments; axis rather strongly convex; about as wide as the lateral lobes. Pleurae geniculated at an obtuse angle, at a little less than half their length from the axial furrows; strongly facetted in the outer half. Pleural groove most distinctly impressed about the mid length of the pleurae, not reaching the outer extremities.

Pygidium not so convex as the head; nearly semi-circular; a narrow convex border all around the sides and posterior extremity; axis conical, extending to the marginal border. There are ten or eleven segments in the axis, and six or seven (each with an obscure median groove) in the side lobes.

Length of an entire specimen, seventeen lines; width, eleven lines; length of head, six lines; of the thorax, seven lines; of the pygidium, five lines.

It would be difficult to establish a difference between P. phocion and P. conradi Hall[1] and there is none between the Gaspé trilobite and

[1] See Palaeontology of New York. 1888. 7:89, pl. 20, fig. 9; pl. 21, fig. 27, 28; pl. 22, fig. 4.

the form identified by me as P. conradi[1] from the New York Oriskany save the presence in the former of a low tubercle on the neck ring and I am not altogether certain that this may not exist on the latter.

Localities. Widely distributed in the upper limestones on the Grande Grève coast; also present in Percé Rock but rare.

Cordania becraftensis Clarke

Plate 9, figure 11

Cordania becraftensis Clarke. N. Y. State Mus. Mem. 3. 1900. p. 22, pl. 2, fig. 18 (C. hudsonica), 19–23

Specimens of this species are very characteristic cranidia, clearly identical with the forms from the Oriskany of Becraft mountain.

Localities. Grande Grève and loose at Peninsula.

Cordania gasepiou nov.

Plate 9, figures 9, 10

Body small, oval, cephalon with ovoid coarsely tubercled glabella and small basal lobes, small and highly elevated eyes beneath which the cheeks are excavated and concave and the anterior limb also concave and broad, bordered by an upturned thickened rim; genal angles extended into slender spines reaching more than two-thirds the length of the thorax. There may be a spinate tubercle on the neck ring but this has not been determined. The thorax has segments which are crested in the axial line by a row of spinules apparently increasing in length somewhat posteriorly and the lateral moieties of the segments are finely pustulose. The pygidium has a strongly elevated axis and the medial spines are higher and more recurved than those of the thorax. The pleurae are depressed convex and about the margin concave without a marginal rim. The pleural ribs are distinctly duplicate and equally so near the margin. All the pygidial ribs carry fine tubercles. The length of an entire specimen is 11 mm, width 9 mm.

This species has much in common with Cordania becraftensis. We do not know the latter so well but though its size is considerably greater, its pygidium shows a similar duplication of the ribs and a cristate axis though this crest appears to be composed of elevated tubercles and not spines.

Locality. Lehuquet's Cove, Forillon. Gasepiou is said by the Jesuit fathers to be the Micmac name for the Forillon.

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[1] N. Y. State Mus. Mem. 3. 1900. p. 25, pl. 2, fig. 11–16.

Lichas bellamicus nov.

Plate 3, figures 5–7

This is a species of medium dimensions having the lobation of cephalon and the outline of the pygidium very similar to the corresponding parts in the prevalent forms of Lichas from the Helderbergian.

The frontal lobe is pyriform, not elevated or bombate but uniformly convex, without abrupt posterior slope; the lateral furrows are deep and the converging lateral lobes elongate, of about equal width throughout and divided only by an extremely faint cross furrow. The grooves dividing these outer glabellar lobes forming the fixed cheeks are very shallow, and these cheeks are convex and elongated about the eye lobes. The cephalon appears to be bounded by a smooth margin which is flat in front. The entire surface except the furrows is coarsely tubercled and it would appear that some of the tubercles at the crest of the frontal lobe are extended into thick spinules. Parts of a pygidium indicate that this organ was flat and extended and the margin carried long flat spines.

The similarity of this species to Lichas bigsbyi of the Helderbergian is seen in both glabella and pygidium, though the former does not here become conate as in L. bigsbyi. We have elsewhere noted the fact [Pal. N. Y. 8:80] that it is probably to L. bigsbyi that the pygidia appertain which are figured in Palaeontology of New York, v. 3, as belonging to L. pustulosus. The concurrence in the Grande Grève strata of pygidia and cephala of like structure to these would seem to substantiate this argument.

Localities. In the cherty strata between Grande Grève and Little Gaspé.

Lichas (Gaspelichas) forillonia nov.

Plate 1, figures 1, 2; plate 2, figures 1 3; plate 3, figures 1–4

The limestones of Grande Grève contain a Lichas of large proportions and extravagantly spinous. The several parts we have found are, on account of the great spines, intricately complicated with the matrix and it has been possible to extricate them only at the cost of infinite labor and patience. The species is not common and our specimens represent three cranidia with separated cheeks. The general type of cephalic structure irrespective of the spines is practically that normal to such typical expressions of Lichas as seen in Arges, Ceratolichas, Hoplolichas and Conolichas, the frontal lobe being large, ovoid and prominent, not set off by deep lateral grooves as in Terataspis but most prominently elevated posteriorly. The lateral lobes are long and narrow, subcrescentic in form and but very slightly elevated so that the surface between the dorsal furrows is low, gently convex and very long, terminating posteriorly in a more elevated tri-

angular area. The prevailing aspect of the cranidium and glabellar lobes is that of narrowness and length, particularly in the distance between the nuchal furrow and the frontal lobe. The nuchal furrow is broad and low and the occipital ring broad, flat and arched.

Spines. While the general surface is tubercled and some of the tubercles become developed into short spines the major spines are as follows: three pairs, one in front of another on the crest of the glabella; these are of great size and strength and deeply curved backward. They seem to be all of about the same length. In some of our specimens the posterior pair curves backward in a long arch to and beyond the posterior margin of the head, but in a younger specimen they are shorter. The middle and anterior pairs are quite as long. In section these great frontal spines or hooks are not circular but somewhat flattened on the opposing faces, rounder on the outer surface and narrow fore and aft. In our first preparation of these specimens we found only two pairs of these spines but material subsequently acquired indicates that there were three.

On each lateral lobe where widest, and just above the dorsal furrows, is a spine of less hight than the foregoing and apparently erect and these are flanked in front by a much shorter pair. These five pairs seem to be all there are on the glabella except for the spinous tubercles in the occipital area.

The occipital ring bears at its edge on the axis a series of long curved flat or vertically compressed spines, one at the middle and one diverging from the axial spine, at each side. These are neither as long nor as large as those of the frontal lobe but they must have reached back over several of the thoracic segments. The occipital ring is deeply contracted at the dorsal furrows and where it expands again beneath the cheeks it extends, on each side, out into a flat but straight and slender spine larger than the others. This makes five spines on the neck ring, fifteen in all on the cranidium, seven pairs and one axial. It would be natural to expect others on the palpebral lobe but these seem to be wanting.

The other parts of the species are represented by portions of free cheeks which indicate that these ran out into short, thick and narrow genal extensions with a row of rather small spines along the occipital margin, while just outside of the eye near the margin there was a very large, long and recurved hook like those of the frontal lobe. There is still some uncertainty as to the exact details of these parts, due in large measure to the difficulty of extracting them from the rock.

The features here present constitute the most extraordinary development of spines yet observed amongst the trilobites. Yet upon consideration of the generic relations of the species and its affiliation with previously known forms we may observe that this extreme spinosity is the manifestation of epidermal excrescence which has long been recognized as the accom-

paniment of a decadent organic type. It is not in them then, their presence, arrangement, number or strength that we should look for crucial generic traits; rather they serve to obscure such characters. Several lichad genera, Terataspis, Hoplolichas, Ceratolichas, have been chiefly based on these ephemeral phenomena while it is in the form and degree of glabellar lobation that the more dependable differentials are to be found. In this respect there is here senescent return to the typical expression of the genus in the early Siluric, i. e., in the fused lateral lobes and the irregularly hour-glass shaped middle lobe, more prominent in front. Ceratolichas, founded on small species from the Onondaga limestone of New York, bears a similar elongate, though more elevated, frontal lobe with a single, double or even triple pair of recurved spines at its posterior end. Terataspis grandis, the magnificent species of the Schoharie grit of New York and the Decewville beds of Ontario, has an egg-shaped, highly constricted glabella without spines, but stout spines on the lateral lobes and a row of club-like projections on the occipital ring. Ceratolichas[1] also bears a pair of strong spines on the free cheeks and a long double central pair on the neck ring. Fugitive as such expressions must be we fail to express the important share of these forms in the phylogeny of the genus if they are left solely with the designation of the typical or Siluric forms like L. laciniatus Dalman on which the genus was founded. I should not, therefore, place L. forillonia with any of the genera above specified but purpose to express its singular distinctiveness in the subgeneric term Gaspelichas.

Dimensions. The largest of the specimens affords the following measurements: Probable entire length to tip of axial spine, 90 mm; length of posterior glabellar spine (not restored), 41 mm; on the curve, 55 mm; greatest vertical hight of anterior spines (not restored), 30 mm; length of lateral occipital spines, 27 mm; vertical hight of spine on cheek, 30 mm. These figures indicate that the species is one of the largest as well as the most extravagantly ornamented of all forms of Lichas. It is surpassed in dimensions only by Terataspis grandis and Uralichas ribeiroi, the lords of this tribe. Equipped with cerements of mortality, successors of this genus Gaspelichas are hardly to be expected.

Localities. Chiefly in the lowest beds of the Grande Grève limestones on Dolbel's brook with Hipparionyx proximus, Megalanteris, Leptostrophia magnifica. Also in the higher cherty beds along the shore at Grande Grève.

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[1] C. gryps H. & C. C. dracon H. & C. See Palaeontology of New York, v. 7, pl. 19B., fig. 7–18b.

Ceratocephala robinia nov.

Plate 3, figures 9–11

In the fauna of the Oriskany of New York I have noted the presence of fragments of this genus which have been referred by me to C. (Acidaspis) tuberculata Conrad, which is originally and typically from the Helderbergian. Nothing is known of this Oriskany form except the cranidia. There occurs in the Grande Grève limestones a form known from various parts and one nearly entire specimen, which attains much larger proportions than C. tuberculata and yet is allied to both that species and the C. callicephala from the Onondaga limestone. Placing these species in comparison we may find the distinctive characters expressed as follows:

	C. tuberculata	C. callicephala	C. robinia
Size	Small	Medium	Large
Neck ring	With short stout spine	With small spine	With longer, stout and somewhat curved spine
Thoracic segments	Finely tubercled	Regularly and coarsely tubercled	Coarsely tubercled
Pygidium 1st spines	Moderately long	Slender and longer than 2nd pair	Very short
2d spines	Much longer	Shorter than 1st pair	Longer than 1st pair
3d spines	Large, stout and twice the length of 2d pair	Not conspicuously the largest of the series	Sharp and slender, longest
4th spines	Very short	Relatively long and slender	Sharp and slender more than ½ the length of 3d pair
Surface	Strongly tubercled	Tubercled	No tubercles

These differences will be found to pertain chiefly to minor features but we conclude that there is in the Gaspé specimens a distinction from these allies in time and structure which is clearly defined and significant in the

interpretation of these faunas. It is not at present possible to say whether the New York Oriskany species is of the same type.

Dimensions. The only specimen which we have observed having the parts together is in the Redpath Museum of McGill University. We owe to Professor F. D. Adams the opportunity of studying this example. It is from Grande Grève and has a length of 20 mm. Cranidia of other specimens are of about the same size.

Localities. At various outcrops on the upper horizons along the Grande Grève coast. The same form is more abundant at the Percé Rock.

Species name. Charles Robin, organizer of the fishing industry in Gaspé and founder of the Robin-Collas establishments, 1766.

Aparchites nov.

Small, compressed convex valves of subcircular outline. The dorsal edge straight and short (one third as long as the valve), the antero-dorsal and postero-dorsal angles obliquely truncate; anterior and posterior margins equally rounded and forming a continuous curve with the frequently somewhat less rounded ventral margin. The valve is mostly uniformly convex and the apex in the middle; sometimes the area along the dorsal margin is a little depressed and flatter than the rest of the valve. The lateral and ventral margins show a narrow bevel. The surface is smooth when seen with the naked eye, but shows a very fine pitting when observed with a strong lens.

The genus Aparchites is stated by Ulrich to extend from the Lower into the Upper Siluric. The present form appears to be more similar to the type of the genus [Ap. whiteavesi Jones Ann. & Mag. Nat. Hist. 6 ser., v. 3, 1889 from the Trenton of Manitoba] than to the others, but it differs from that species in its shorter dorsal line.

Locality. Grande Grève.

Bythocypris sp. nov.

Plate 9, figures 17–19

Specimens are common of a Bythocypris closely related to B. cylindrica Hall of the upper Lower Siluric. The present form is very small, .9–1 mm long, .3 mm wide; in outline identical with B. cylindrica as figured by Ulrich [Pal. Minn. v. 3, pt 2, pl. 44, fig. 29–32], with which it also sometimes agrees in size, while other specimens are slightly shorter and rounder, and their anterior part less pointed. These differences in outline would, however, not be sufficient for specific distinction. The valves appear also to be a little higher or more convex than those of B. cylindrica,

the greatest convexity being found in the posterior third, while in the typical B. cylindrica the valve culminates in the middle.

The valve possesses an internal vertical thickening of the median part, which produces a broad shallow impression upon the cast of the interior surface.

The surface is so finely pitted that this sculpture is visible only with great enlargement.

Locality. Shore outcrops at Grande Grève.

CEPHALOPODA

Kionoceras rhysum nov.

Plate 13, figures 1–5

Straight longicones with regular narrow, erect annulations which may be slightly oblique and are separated by broad, smooth, concave or flat interspaces. On the best preserved external casts there is no trace of either longitudinal or concentric lines but the summits of the annuli are dotted or punctured.

This form is represented by specimens for the most part small, in which there are on the average 6 annuli in a length of 20 mm, but other examples indicate that the species attained large proportions.

Locality. At various outcrops in the upper beds on the Gaspé Forillon.

Kionoceras champlaini nov.

Plate 13, figure 8

This species is represented by longicones having a series of low and broad undulations of the surface continuing quite to the aperture and these are crossed longitudinally by elevated, distant, simple lines with broad flat interspaces, each about twenty-five in number, the former becoming obsolete at the aperture.

This species is of rare occurrence and its characters distinctive. The best preserved specimen has a width of 22 mm at the aperture and a length (incomplete) of 50 mm.

Locality. Indian Cove.

Orthoceras sp.

Smooth, straight cones with regularly concave septa.

Locality. Grande Grève.

"Cyrtoceras" sp.

Curved camerate longicones are found occasionally in the limestone but they are not more exactly determinable.

Locality. Grande Grève.

PTEROPODA

Hyolithus richardi nov.

Plate 12, figures 14–17

Shell large, tapering gradually; ventral face flat or slightly concave; dorsal face highly arched, subcarinate axially; apertural margin not produced on either face. Semioval in transverse section, apertural diameter to length as 1 to 3.5. The shell is slightly arched axially, the margins and the dorsal face being correspondingly incurved. The ventral surface is marked by very fine lines concentric to the slightly reentrant curvature of the margin; it is not crossed by vertical lines except those of structure, but the axial area may be flat and its boundaries present the aspect of vertical lines or depressions.

The opposite or arched surface bears a series of rather coarse subequal vertical ridges separated by flat and broader intervals. Near each margin is a deeper groove; obscure concentric striae are also preserved on this surface. The apertural margin of this face is slightly inflected.

Length of average specimen 35 mm; apertural diameter 8 mm.

Locality. Grande Grève.

Species name. André Richard, Jesuit missioner on the Gaspé coast, 1661.

Hyolithus oxys nov.

Plate 12, figures 10–13

Shell usually larger than the foregoing and relatively much broader, margins tapering more rapidly, surface slightly arched axially. Ventral face gently convex throughout and produced at the margin beyond the opposite face into a semielliptical extension; dorsal face convex but much less so than in H. richardi, the median portion the most elevated and bounded by two longitudinal grooves. Apertural diameter to length of ventral face as 1 to 2.5; of dorsal face as 1 to 2. The surface is marked only by concentric striae, arched upward on the dorsal face to correspond with the curvature of the margin; transverse on the ventral face. Average specimens measure 40 mm in length and 14 mm in apertural diameter.

Locality. At Grande Grève and Indian Cove.

This is a more abundant species than its associate.

Conularia cf. desiderata Hall

Plate 11, figure 12

Conularia cf. desiderata Clarke. N. Y. State Mus. Mem. 3. 1900. p. 28
See Conularia desiderata Hall. Palaeontology of New York. 1859. 3 : 480, pl. 72, fig. 4

This small and slender species from the Oriskany of Becraft mountain has no vertical grooves on the four faces but the transverse striae make a sharp upward turn medially; the striae themselves are very faintly tubercled.

Grande Grève shells of this character are provisionally placed here.

Locality. Grande Grève.

Conularia desiderata Hall var. **tuzoi** nov.

Plate 11, figure 13

This is a large shell having the surface characters similar to those of C. desiderata, that is consisting of fine transverse lines bending backward at the center and bearing extremely obscure tubercles visible only when the preservation is exceptional. Unlike C. desiderata the shells bear evidence of a faint median vertical but not interrupting line on each face.

Locality. Percé Rock.

Variety term. Tuzo, a well known Jersey patronymic at Percé.

Conularia penouili nov.

Plate 11, figures 10, 11

A large species distinctly grooved at the angles and ridged at the middle of each face. The concentric markings are elevated lines close together and curving broadly upward. These are smooth on the edge, without ornament, but the interspaces have sculpturing consisting of a series of low subcircular depressions in transverse rows separated by elevated surfaces which may take on the form of short convex pillars. This ornament is only about the middle of each face; toward the edges it fades away or is replaced by fine longitudinal puckers starting with the upper slope of a transverse ridge and passing down the slope and part way across the interspace.

Locality. Found loose in a limestone block at the Peninsula, Gaspé.

Specific name. To the early French explorers Gaspé bay was the Baie du Penouil.

Conularia lata Hall *mut.*

Plate 11, figures 6-9

Conularia lata Hall. Palaeontology of New York. 1859. 3 : 479, pl. 70A, fig. 3, a, b; pl. 91, fig. 1

The type specimen of C. lata is of very large dimensions and indicates in some respects an exaggeration of the features presented by those

here identified with it. The latter are also of considerable size, the ornamental transverse lines being crested with round tubercles which in some places, especially near the sulci of the angles, may be elevated, the interspaces being broad and smooth and the longitudinal line at the middle of each face always faint. There is no difference in the general type of external ornament and hence the Gaspé species may be identified with that from the Oriskany of New York.

Localities. In the upper beds at Lehuquets Cove, Indian Cove and above Little Gaspé.

GASTROPODA

Platyceras leboutillieri nov.

Plate 14, figures 1–4

Shell small, erect, apex minute not exsert; minutely coiled for 1⅓ volution, then abruptly expanded with a spiral twist, the body whorl being erect and subcylindrical and the total volutions less than two. There is no evidence of spirality in the body whorl beyond the first third of the shell. Section of body whorl circular. Shell growth somewhat irregular in late stages but apparently without nodes.

Aperture but slightly undulated.

Hight from apex to stoma 18 mm, diameter of body whorl near aperture 14 mm.

This small species is of the type of P. spirale and P. lamellosum Hall, of the New Scotland fauna (Helderbergian), more particularly of the latter. It is a rare species in the Gaspé limestone.

Locality. Percé Rock and Grande Grève.

Specific term. LeBoutillier, a Jersey name prominent in the history of the fishing in Gaspé and specially, Philip LeBoutillier of Percé, contemporary and aide of Sir William Logan.

Platyceras cf. **fornicatum** Hall

Plate 14, figures 8, 9

See P. fornicatum Hall. Palaeontology of New York. 1867. 4: 11, pl. 4, fig. 1–5, 7, 8, 18–20

The most common Platyceras in the limestones is a stout, subtrihedral shell with rather small spire, flattened upper whorl surface and deep lower surface, the flattening making a distinct angular ridge along the whorl. The surface bears a few irregularly scattered low nodes. Platyceras fornicatum is a shell from the fauna of the Helderberg limestone of New York and though it may not prove fully identical with this serves the purpose of comparison which is nearly all that can be safely attempted among these protean capulids.

Locality. At various outcrops of the upper beds at Grande Grève, Indian Cove and Shiphead.

Platyceras cf. **nodosum** Conrad

Plate 10, figures 10, 11

cf. Platyceras nodosus Conrad. An. Rep't on Palaeontology of New York. 1841. p. 56

Platyceras nodosum Hall. Palaeontology of New York. 1859. 3: 473, pl. 115, fig. 1–6; pl. 116, fig. 1–4

With this well known Oriskany species may be compared some shells of smaller size in the Gaspé limestones, with nodose surface and generally rounded subsymmetrical whorls. This latter feature distinguishes them from the following species.

Localities. In the shore outcrops near Grande Grève.

Platyceras paxillifer nov.

Plate 14, figures 13, 14

A small shell closely coiled for 2½ volutions or throughout its length, rapidly expanding and having the general aspect of a shallow Diaphorostoma or Strophostylus; the surface roughly corrugated concentrically, the upper shoulder of the shell bearing a single row of slender spines, beginning, in the best preserved specimens, at the end of the 2d whorl or the commencement of rapid expansion, and three in number at unequal intervals. This species represents one of the large group of spined Platycerata so frequent at this period in the development of the genus, though none of this type have been described from the Helderbergian fauna yet representatives are known to occur therein, and in the Oriskany of Glenerie we have the multispinous shells P. nodosum Conrad and P. subnodosum Hall, which usually appear in the form of nodate casts.

In the Onondaga limestone fauna are P. dumosum, echinatum, multispinosum, fornicatum but among them all is none of the type expressed in P. paxillifer.

Locality. Upper beds about Grande Grève.

Platyceras tortuosum Hall

Plate 14, figures 22-25

Platyceras tortuosum Hall. Palaeontology of New York. 1859. 3: 472, pl. 113, fig. 1–5

This species, found in the form of internal and external casts in the arenaceous Oriskany of New York, is apparently represented by specimens which at Percé attain much greater dimensions than the New York shell. The conch is a much elongated and gently twisted cone, greatly corrugated longitudinally on the columellar side. The apex is exsert, the total coiling not more than 1¼ volutions and the expansion rapid though regular to the aperture. The stoma is considerably undulated.

Some of the representatives of this species in the Percé Rock attain notable and occasionally extraordinary size. While the New York shells have a length from apex to stoma averaging 45 mm, the former are not infrequently 70 mm long, and a single fragment indicates a length of more than 10 cm. The exterior of the shell as indicated by a Grande Grève example is covered with fine concentric lines caught back at intervals along revolving lines corresponding to the folds of the interior. The species is of more slender form than P. dentatum Hall of the Onondaga limestone.

Localities. Rather common at Percé Rock. Rare in the chert bearing beds at Grande Grève.

Platyceras guesnini nov.

Plate 14, figures 17-19

Shell of medium size, suberect, subsymmetrically coiled; apex deeply coiled in horizontal plane, rapid expansion beginning at 1½ volutions, body whorl irregularly expanded, subcircular in cross section, direct and unattached for one half its length. Surface without revolving furrows and ridges, and marked with subequidistant concentric undulating fringes gradually becoming obsolete near the aperture; also traversed longitudinally by very fine revolving lines.

Locality. Percé Rock.

Species name. Hilarion Guesnin, Recollet Missioner at Percé about 1670.

Platyceras lejeunii nov.

Plate 14, figure 12

Shell of medium size with relatively small coil and rapidly expanding suberect body whorl. Surface with subspiral or somewhat twisted longitudinal ridges crossing and festooning irregular concentric growth lines. The surface is covered with very long and slender spines which are curved or arched backward. The shell is more slender than other echinate species and the spines relatively longer and more arched.

Locality. In the upper beds at Grande Grève.

Species name. LeJeune, the first of the Jesuits to arrive in Gaspé after the recovery of Canada from the English in 1632.

Platyceras (Orthonychia) belli nov.

Plate 14, figures 20, 21

Shell erect, minutely arched and incurved at the apex, expanding very gradually but equally for nearly one half its length and thence more abruptly, the cross section of the whorls being essentially circular and the stomal margin undulated. Surface crossed transversely by rugose concentric growth lines, their undulations corresponding to low grooves and folds of the shell. Length of a full-sized specimen 50 mm; stomal width 33 mm.

This species is of the simply conical type expressed by P. plicatum, P. elongatum and P. pyramidatum Hall of the New Scotland fauna[1] and by P. conicum Hall of the Onondaga and Hamilton faunas[2]; of all these it approaches most nearly P. pyramidatum.

Locality. Grande Grève.

Platyceras sp.

Plate 14, figures 5-7, 16

Other distinct forms of this genus are indicated but material is insufficient for conclusive determination. Of these all are of medium size and (1) one is subsymmetrical with spiral of nearly 2 volutions in apposition, the body whorl expanding gradually and remaining long and slender. It was thus a suberect and narrow shell. Its surface is crossed by the usual coarsely concentric lines and along the periphery of the spiral are a few scattered spine bases, there being none further down the whorl; (2) a somewhat similar form with larger spiral, narrow nearly symmetrical body, subcarinate periphery with a broad and low revolving furrow on each side; also a suberect shell without spines or nodes. Both of these forms are from Grande Grève. (3) A more erect smooth shell, with minute and slightly coiled or twisted apex, very rapidly expanding and bell shaped body, somewhat flattened above and expanded below; stoma undulated, cross section subcircular but not symmetrical; surface apparently smooth. This is from Percé Rock.

Holopea cf. **antiqua** Vanuxem

Plate 15, figures 12-14

See Holopea antiqua (Vanuxem) Hall. Palaeontology of New York. 1859. 3: 294, pl. 54, fig. 2, 3

These are obconical, rather rapidly expanding shells with moderately elevated spire and evenly rounded whorls which have the proportions and size of the species cited, and though we do not know the character of the exterior it is evident from internal casts that it was essentially smooth or with only fine concentric lines. Our specimens have a hight, in an average example, of 22 mm and an apertural width of 20 mm.

The New York specimens of H. antiqua were described from the Tentaculite or Manlius limestone lying at the base of the Helderbergian series.

Locality. Grande Grève.

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[1] See Palaeontology of New York. 1859. 3: 334-36, pl. 64.

[2] *Idem*. 1867. 4: 3, pl. 1, fig. 13-23.

Diaphorostoma ventricosum (Conrad)

Diaphorostoma affine (Billings)

Diaphorostoma desmatum Clarke

Diaphorostoma perceense nov.

Plate 15, figures 17–23

Platyostoma ventricosa Conrad. Jour. Acad. Nat. Sci. Phila. 1842. 8:275, pl. 17, fig. 5

Platyostoma ventricosa Hall. Palaeontology of New York. 1859. 3:300, pl. 55, fig. 9

Platyostoma affinis Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 60, pl. 5, fig. 2

Diaphorostoma desmatum Clarke. N. Y. State Mus. Mem. 3. 1900. p. 29, pl. 3, fig. 13–19

The names above cited apparently express definite local values, more or less combined in the New York Oriskany shells but differentiated in the Gaspé faunas. Diaphorostoma ventricosum (Oriskany of New York), if restricted to the large shells with expanded whorls and broad stomata, is variable in the hight of its spire, and this feature is shown by Hall's figures. Perhaps the degree of elevation never attains that presented by Billings's D. affine (Grande Grève), which is based upon this differential. If this difference is applied to the larger Gaspé shells it will serve as a valid basis of distinction. The large shells very abundant in the Percé Rock have uniformly depressed spire, the apex of which is generally not above the upper plane of the body whorl. Diaphorostoma desmatum was based on smaller shells from the Becraft mountain Oriskany, with a highly developed cancellated surface and relatively narrow body whorl. There is little doubt that these do not represent an early growth condition of D. ventricosum for large specimens of the latter obtained from Glenerie near Kingston, N. Y., show, on the early whorls, sharp concentric striae without revolving lines. Typical examples of D. desmatum are frequent at Grande Grève, while the large form called D. affine is quite rare. The shells at Percé fail to show at any stage these peculiarities of surface, the sculpture consisting of fine compressed concentric striations.

The differentials, then, in these shells are as follows:

D. ventricosum; large, with body whorl greatly expanded, flattened on the periphery; spire usually low, never depressed, sometimes moderately elevated. Surface with sharp concentric lines on early whorls; in mature whorls these lines are confluent and obscure. Union Springs, Oriskany Falls, Glenerie, Becraft mountain, Grande Grève (?) etc.

D. affine; large shells with high spire and large penultimate whorl. Grande Grève, New York (?).

D. desmatum; small, with sharply cancellate surface. Glenerie, Becraft mountain, Grande Grève.

D. perceense; large, robust and ventricose shells with spire depressed or overlapped so that the outer whorl is often higher than the penultimate. Surface with fine compressed concentric lines which are not more distinctly marked on early whorls. Percé.

Strophostylus expansus Hall var.

Plate 15, figures 15-16

See Strophostylus expansus (Hall) Clarke. N. Y. State Mus. Mem. 3. 1900. p. 30, pl. 3, fig. 24

The shell identified by the writer from the Becraft mountain Oriskany as Str. expansus Hall is essentially reproduced in the Grande Grève limestone. These shells which are of persistently smaller size than typical S. expansus of the Glenerie Oriskany as well as the arenaceous beds of central New York, seem to indicate that the distinction which is apparently persistent is worthy of noting in the absence of the larger expressions in association therewith.

Locality. King's road, Grande Grève.

Eotomaria voltumna Billings (sp.)

Plate 16, figures 1, 2

Pleurotomaria voltumna Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 61, pl. 5, fig. 5, 5a

Original description. Shell sub-turbinate or sub-globose; apical angle between 90° and 100°; spire consisting of about three rounded or obscurely lenticular whorls with a three-grooved band about the mid-hight; aperture obscurely subrhomboidal, with, apparently, a tendency to become effuse at the lower angle; umbilicus very small. Surface with rather coarse transverse striae, about three in the width of one line, curving backwards from the suture to the band. Width, fifteen lines; hight, thirteen lines; width of the band near the aperture, about two lines.

Of this species only one imperfect specimen has been collected. The surface of the whorl, above the band, slopes upwards to the suture, with a gently convex curve, slightly more flattened just above the band than near the suture. The same form prevails below the band where the curve of the surface, at first moderate, becomes abruptly convex around the umbilicus.

The band, in this specimen, consists of three concave grooves, the lower one, as seen on the body whorl, being the largest, and the upper the smallest, the three near the aperture occupying a width of about two lines.

Locality and formation. Grande Grève, Gaspé; limestone no. 8.

We have seen no example of this species, except the original, which is here reproduced.

Eotomaria lydia (Billings)

Plate 16, figures 3, 4

Pleurotomaria lydia Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 62, pl. 5, fig. 4, 4a

Original description. Sub-turbinate, turreted; spire of three or four whorls, somewhat oblique; apical angle 90° or a little greater; umbilicus open, about one fourth the width of the base. Hight, ten or twelve lines; width, twelve or fourteen lines. The outside of the body whorl, near the aperture, is nearly vertical, gently convex, more rounded as it recedes towards the apex. The band is situated on the upper outer margin of the whorl, and is indicated in this position, on the cast of the interior, nearly to the apex. Above the band the surface of the whorl is nearly flat, and nearly at a right angle to the vertical axis of the shell at the aperture, but becomes more convex as it approaches the apex. The umbilicus appears to be about one fourth or one third the whole width of the base. The aperture appears to be somewhat effuse at the lower angle. The base of the whorl around the umbilicus is uniformly convex, becoming obscurely angular at the aperture.

Surface with fine striae, curving backwards above the band and forwards below.

Locality and formation. Indian Cove, Gaspé; limestone no. 8.

We have seen but a single specimen except the original, which can be safely referred to this species.

Eotomaria ? rotula nov.

Plate 16, figures 11–14

Shell small, spire greatly depressed below the level of the final whorl, so that the coiling has proceeded almost in a horizontal plane. Whorls about 2, gradually expanding and all in contact. Outline of body whorl bilaterally subsymmetrical, expanding on the lower side to the stome. It bears a peripheral elevated or convex band which is bounded above by a sulcus, though not so well defined below. The upper shoulder of the whorl is subcarinate while the lower surface is broadly rounded and bears an oblique sulcus on the final third of the volution. Aperture sinuous, projecting above and reentrant in a broad curve below the position of the peripheral band. Surface crossed by fine concentric lines which curve forward on the upper surface of the whorl and make a retral turn on the periphery whence they again curve forward in a broad sweep on the lower surface being interrupted by the interior sulcus.

Dimensions. Diameter 14 mm ; hight 9 mm.

Locality. Grande Grève.

Eotomaria delia (Billings)

Plate 16, figures 6–8

Pleurotomaria delia Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 61, pl. 5, fig. 3

Original description. Turbinate; base convex; spire of three or four whorls, obliquely conical; apical angle 90° or a little more; a band about the mid-hight; umbilicus minute

or closed; hight, about twelve lines; width, fifteen to eighteen lines. The base of the body whorl is strongly convex; the band on approaching the aperture is situated above the mid-hight, but receding therefrom it gradually gains a position on the outer edge of the whorl; in the upper whorls it seems to be concealed in the suture. The upper side of the body whorl, near the aperture, above the band, ascends with a gently convex or nearly flat slope to the suture; approaching the apex the whorls become more convex. The band appears to be rounded and about one line wide at the aperture. The aperture is somewhat effuse below. Surface with fine striae and some stronger ridges of growth near the aperture.

Locality and formation. Grande Grève, Gaspé; limestone no. 8.

We have here figured the type specimen which has about the same degree of imperfection as our own examples. The shell is not common.

Localities. Gavey's, Lehuquet's and elsewhere, Grande Grève.

Trochonema lescarboti nov.

Plate 16, figure 5

Shell moderately large, trochiform. Whorls broadly sulcate above, gently convex peripherally and regularly convex below; 3–4 in number. Sutures impressed and bounded by an elevated ridge or carina within which the surface is depressed in a broad and shallow sulcus bounded outwardly by a sharp keel which lies at the shoulder of the whorl and from which the whorl surface is abruptly depressed. No peripheral band is known though the internal cast bears a peripheral depression. Lower surface not known except from the cast, apparently regularly convex. Surface marked by regular concentric lines without revolving striae.

Dimensions. Width 35 mm; hight 23 mm.

Locality. Percé Rock.

Species name. Lescarbot, explorer (1604) and historian (1612) of New France.

Coelidium egregium (Billings)

Plate 17, figures 29, 30

Murchisonia egregia Billings. Palaeozoic Fossils. v. 2, pt 1. 1874. p. 58, pl. 5, fig. 7

Original description. From three to four inches in length, apical angle about 20°; whorls apparently about ten, moderately convex; a narrow band near the basal margin of the whorl. Surface with very fine striae, which above the band curve backwards at an angle of about 30° to the longitudinal axis of the shell; below the band they curve forward again to the suture. The band is one line wide on the last whorl of a specimen three and one half inches in length. It is also once or twice its own width from the suture.

The locality of this species is given as the Gaspé sandstone, head of falls of the Dartmouth river. This ascription of the formation is, we are disposed to believe erroneous. Just beyond Ladysteps brook, a branch

of the Dartmouth, the latter crosses the outcrops of the Grande Grève limestones which are here marked as fossiliferous on Dr Ell's map. The matrix of the originals is a gray argillaceous limestone such as does not, as far as we have observed, occur in the Gaspé sandstone. We hence venture to include it in the limestone fauna.

Coelidium hebe (Billings)

Plate 17, figures 31, 32

Murchisonia hebe Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 57, fig. 28; pl. 5, fig. 6

Original description. From three to four inches in length; apical angle about 20°; whorls, about ten in a specimen three and one half inches in length, uniformly and moderately convex; a narrow band in the middle. Surface with fine striae which curve backwards to the band, forming therewith an angle of about 40°.

A specimen consisting of the five last whorls and about half of the aperture is thirty-three lines in length. Width of the last whorl, twelve lines; and of the fifth whorl from the base, five lines. From the middle of the body whorl to the middle of the fifth, the length is twenty-one lines. The specimen therefore tapers seven lines in a length of twenty-one. When perfect it probably had nine or ten whorls.

Another specimen with six whorls is thirty lines in length; width of last whorl, twelve lines, and of the fifth, four and one half lines. This specimen retains the surface markings and band on a part of the body whorl. The band is about one line in width.

Specimens of this type, of much the same inferior preservation as those described by Billings, are common in the limestones; none however add much to our knowledge as they are mostly of inferior quality and show no traces of the slit-band seen in the original. These shells carried a band at the suture while the surface was concentrically crossed by extremely fine lines.

It is a species very similar to Hall's Loxonema fitchi and L. planogyrata from the Helderbergian of New York.

Localities. At Grande Grève, Indian Cove (the original locality), Shiphead and all coast outcrops.

Bellerophon plenus Billings

Plate 17, figures 25–28

Bellerophon plenus Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 62, pl. 5, fig. 8a, b

Original description. The casts of the interior of this species are broadly rounded on the dorsum; narrowly convex around the umbilicus; the aperture transversely expanded. In the transverse section the inner side of each whorl is indented to the extent of one third, by the dorsum of the preceding whorl. The umbilicus, measured across from the most projecting points of the whorl around it, is about one third of the whole diameter of the shell. It diminishes in width rapidly inwards. The keel appears to be about one line wide at the aperture. None of the surface characters are seen on the casts, except

some obscure wrinkles on the dorsum which diverge from the keel forwards and outwards, forming with the keel an angle of about 45°. Transverse diameter of the aperture of a large specimen, eighteen lines; vertical diameter (from the dorsal side of the aperture to the opposite side of the shell) about the same.

This is a shell often attaining large size, sufficiently common but seldom found except as internal casts. Its stoma is much more explanate than was indicated by Billings's imperfect figures and as the shell is apparently seamless it appertains to the group of species represented by B. patulus Hall and B. forbesi Clarke of the Lower Devonic. The mature forms display no external ornament except traces of concentric lines, but young shells, some of which have been preserved as silicious replacements, carry a series of elevated revolving lines.

Localities. In the shore outcrops at Grande Grève. Billings's specimen was from Indian Cove.

Bellerophon (Plectonotus ?) gaspensis nov.

Plate 17, figures 17, 18

Shell rotuloid, rapidly expanding; expanded but not explanate at the aperture. Outer surface trilobed by two revolving lateral furrows which start early and become wider and deeper with age. These do not divide the surface equally but the lateral divisions are considerably narrower than the median division which is broad, prominent and elevated but flattened on top and may have had a peripheral seam. The specimen measures 12 mm in diameter and has about the same apertural width.

Species of this type are well distributed throughout the early Devonic and we may cite, P. derbyi and P. salteri Clarke from the River Maecurú, Brazil, and the so called Bell. trilobatus from the Spiriferen sandstone of Germany.

Locality. Grande Grève. The shell appears to be rare, a few examples only having been observed.

PELECYPODA

Aviculopecten jumeaui nov.

Plate 19, figures 4, 5

Shell of considerable size, suberect, explanate below, with suborbicular outline tending to obliquity posteriorly. Beak anterior, anterior wing short, posterior broad flat or subconcave, the point not extending beyond the posterior curve of the shell; sharply incurved on the lateral margin of the shell where that is straight, and oblique to the outer curvature. Surface with fasciculate bands somewhat after the type of ornament in Actinopteria textilis; coarse distant ribs with intermediate smooth spaces divided by a simple low rib, these interspaces being subdivided near

the margin. Concentric sublamellose lines at distant intervals. On the wing radial lines are obscure but concentric lines sharp and crowded.

Dimensions. The typical specimen has a length of 47 mm; hight of 42 mm.

Locality. Percé Rock.

Species name. Jumeau, Recollet colaborer with Chrestien LeClercq at Percé.

Aviculopecten ? incrassatus nov.

Plate 18, figure 1

Shell large, outline obliquely subelliptical. Posterior wing short. Surface with coarse and heavy radial ribs of unequal size separated by relatively narrow rounded grooves. Inequality in the size of the ribs is noticeable in the umbonal region and new ribs are added by division of the large ones. All are crossed by a concentric ornament of fine compressed lines with occasional deep concentric growth furrows. This type of ornamentation is an extreme condition of that sometimes expressed by Pterinopecten proteus. The original specimen has a hight of 50 mm and a probable length of 70 mm.

Locality. Grande Grève.

Actinopteria communis (Hall)

Plate 19, figures 8–12

Avicula communis Hall. Palaeontology of New York. 1859. 3: 286, pl. 52, fig. 1–7; pl. 53, fig. 1, 4, 6

Actinopteria communis Clarke. N. Y. State Mus. Mem. 3. 1900. p. 34, pl. 4, fig. 1, 2

The Grande Grève material affords an occasional specimen of small size in which the characters of this species are fully developed. In the Percé Rock the species is represented by much larger shells of greater obliquity and these may be regarded as a mutation of the specific form.

Actinopteria communis was described from the Helderbergian fauna but also occurs in the Oriskany of Becraft mountain. The ornament of the wing is strongly lamellar concentrically and in sharp contrast to the rest of the shell. As a whole it is clear that the ornament of this species stands in a primitive relation to the progressed ornament of A. communis and that the simple type of expression in this ornament at adulthood is an indication of arrest of development.

Localities. Along the shores at Grande Grève and at Percé.

Actinopteria textilis (Hall)

Plate 19, figures 1–3

Avicula textilis Hall. Palaeontology of New York. 1859. 3: 288, pl. 52, fig. 9, 10; pl. 53, fig 2, 3, 5, 7, 10
Pterinea textilis? Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, pl. 4, fig. 1

Mr Billings hesitatingly referred to this species a specimen of which he gave a figure but to which no reference was made in his text. Its association on the plate with Gaspé fossils and the actual occurrence of the species therewith leads to the inference that his specimen was from these limestones. The shell is very abundant here and not to be distinguished from the New York forms occurring in the New Scotland (Helderbergian) fauna, except that by virtue of different preservation the former show more distinctly the character of the surface ornament which consist of primary ribs separated by broad interspaces usually divided by a single intermediate rib of small size. This simple ornament prevails over the adult body, but the intercalary spaces become broken up toward the margin in old shells, showing thereby a tendency to the finer alternating surface of A. communis Hall, a common Oriskany species at Becraft mountain.

Localities. About Grande Grève and elsewhere on the Forillon.

Pterinopecten proteus Clarke *mutation*

Plate 19, figures 2, 3

See Pterinopecten proteus Clarke. N. Y. State Mus. Mem. 3. 1900. p. 32, pl. 4, fig. 4–8

The group of shells represented by the Oriskany species Actinopteria (Avicula) textilis and var. arenaria Hall, Pterinopecten (Avicula) recticosta Hall and Pt. proteus Clarke, find allied expression in the fauna of the Gaspé limestones in at least three species. In all these there are but slight variations from the general type of surface ornament though this may be greatly diversified within the limits of a single species; yet it is all of the type of alternating and fasciculate ribs crossed by fine concentric and elevated lines. There is also gradual passage among them from the oblique form we would ascribe to Actinopteria, to the more typical expression of Aviculopecten and thence to the erect form of Pterinopecten. Without attempting, in face of present evidence, to analyze the value of these divisions, we find that with such easy variations amongst these species it is not well to insist on specific identities in all cases of the Canadian with the New York shells.

In describing Pt. proteus we noted the variability of the exterior in shells of one type of outline. In the Gaspé limestones we find shells approximating this outline but even more erect, and with the posterior wing

broader and much less incurved, which present quite regularly alternating radial ribs crossed by elevated concentric lines. These we propose to identify with Pt. proteus recognizing a distinctive difference by the employment of the term mutation. These shells are not common.

Locality. Fruing's, Grande Grève.

Megambonia denysia nov.

Plate 21, figures 8–10

Shell very small, suborbicular in outline and rotund in contour. Auricle not prominent, byssal groove broad, shallow and indistinct, but visible nearly to the beak. Surface very finely radiate on the body of the shell but with fewer radii on the auricle. The orbicular outline, regular convexity and feeble byssal groove seem to indicate this as distinct from the foregoing, though not varying materially in surface characters. Further knowledge of the shell may determine a closer relationship in the two.

Dimensions. Hight and width, 7 mm.

Locality. Percé Rock.

Species name. Joseph Denys, Recollet missioner at Percé, 1685.

Megambonia crenistriata Clarke

Plate 21, figures 6, 7

Megambonia crenistriata Clarke. N. Y. State Mus. Mem. 3. 1900. p. 53, pl. 4, fig. 15–17

This species differs from M. bellistriata of the arenaceous New York Oriskany (Albany and Schoharie counties) in its large auricle with deep sulcus reaching to the beak, the surface of this part being almost free of radial lines. Such evidences as there are of the latter only nick the edges of the lamellose concentric growth lines into a series of obscure scollops; no trace of them is seen either on sculpture or internal casts. Megambonia bellistriata has decided radial lines on the auricle and a very shallow byssal groove.

The Gaspé limestone specimens have the surface finely radiate over the body of the shell as in the New York specimens.

Locality. Rare at Grande Grève.

Cypricardinia distincta Billings

Plate 24, figures 12–19

Cypricardinia distincta Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 56, fig. 26, 27

Under this name the author cited and illustrated the two extremes of variation in this species, one elongate with broad and few growth bands and

the umbonal ridge suppressed probably by compression, the other more rhomboidal in outline, with narrower, more numerous growth bands, sharper umbonal ridge and more sinuous postlateral margin. In the absence of intermediate forms these might be regarded so unlike as to be terms of parallel rather than continuous series.

Original description. Shell oblong or irregularly ovate; compressed or moderately convex; an oblique, obscure angulation extending from the umbones to the posterior angle; umbones sometimes slightly flattened by an obscure depression which descends, gradually widening, to the ventral margin; beak small, closely incurved. Dorsal margin straight, slightly concave or convex, parallel with the ventral margin or a little elevated posteriorly, usually about one fourth shorter than the total length. Ventral margin usually gently concave, but sometimes straight or slightly convex. Anterior extremity usually with the lower half a little projecting and rounded, concave at the mid-hight or obtusely rounded; posterior extremity, with the most projecting point at the mid-hight or a little below, narrowly rounded or angular; the upper half obliquely truncated with a straight or gently convex slope.

Surface with wide sub-concentric rings of growth, the posterior edges of which are abruptly elevated or sub-lamellose. These rings are usually flat, but are sometimes slightly convex or concave.

The largest specimen collected is seventeen lines in length, eight lines in hight at the umbones, and nine lines high at the posterior end of the hinge line. All the others are shorter and proportionally higher. In several specimens which have both valves in connection, the right valve is the most convex.

The surface of the broad growth rings is usually marked by very fine concentric lines and with good preservation the umbonal slope presents a series of fine radial and intersecting surface lines which are sometimes exhibited from the hinge line as far as the middle of the basal margin. Cypricardinia distincta is one of the largest forms of the genus and is unlike the species known to us from the Oriskany fauna. It approaches more nearly the species C. sublamellosa and C. crassa Hall of the New Scotland (Helderbergian) beds of New York.[1] We find these shells to be quite common in the limestones.

Localities. Everywhere along the coast at Grande Grève, Indian Cove and Shiphead.

Mytilarca canadensis Billings

Mytilarca canadensis Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 52, pl. 4, fig. 2, 2a

Of this large species only the original examples and a single additional specimen have been seen by us. It is evidently very distinct from M. nitida and approaches in contour the aspect of Gosseletia.

Billings states that his specimens were from Gaspé, using the term probably in the broad sense.

Our specimen came from the upper beds at Gavey's, Grande Grève.

[1] See Palaeontology of New York. 1859. 3: 267, 268, pl. 50, fig. 1, 2.

Mytilarca nitida Billings

Plate 23, figures 14, 15

Mytilarca nitida Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 53, fig. 22, 23

Original description. Cast of the interior ovate; anterior side gently concave in the upper two thirds, slightly convex below; posterior side broadly and gently convex, a small portion next the beak (indicating the hinge line), straight. Base nearly uniformly rounded. Umbones moderately prominent, obscurely carinate or narrowly rounded. Beak small, closely incurved, almost in contact, slightly turned forwards. Between the beaks there is a short straight hinge line, which forms an angle of a little less than 90° to the anterior side. The outline of the anterior side is elongate, ovate; rounded at the apex; the sides most prominent a little above the middle; thence narrowing to a point at the base. The posterior side of the cast has a compressed margin, about two lines wide at the end of the hinge line, gradually becoming obsolete towards the base. On the anterior side, beneath the beaks, there is a concave space which dies out before reaching the middle. About one line below the beaks there is an obscure projection, indicating the anterior extremity of the hinge line.

The surface shows a few obscure concentric lines and faint radiating grooves. These latter, although apparent on the cast, may not occur on the surface of the perfect shell.

This species differs from M. canadensis in having only a small portion beneath the beaks depressed, while that one has nearly the whole of the anterior side concave. Hight of the largest specimen collected, twenty-one lines; width a little below the middle, thirteen lines; depth of both valves, twelve lines; length of hinge line, six lines.

Locality and formation. Indian Cove; Gaspé limestone, no. 8.

This is more common than the preceding species and is not unlike the Megambonia ovata Hall of the New Scotland fauna.

Localities. Grande Grève and, according to Billings, Indian Cove.

Palaeopinna flabellum Hall

Plate 21, figures 1–5

See p. 107

Palaeopinna flabella Hall. Palaeontology of New York. 1884. v. 5, pt 1, p. 240, pl. 87, fig. 4

It is singular that this rare species in the New York Oriskany known only by a single specimen from the sandstone of Schoharie should prove to be not uncommon in the Gaspé limestones. Before us is a number of specimens of various sizes all showing the characters of the original and exhibiting particularly the nature of the surface ornament. This consists of concentric growth lines which are sharply defined over the anterior and median parts of the shell but posteriorly are crossed by radial lines becoming stronger toward the hinge line and eventually broken up into series of radial asperities. Anteriorly the shells are abruptly bent inward but do not gape, the anterior surface beneath the beak being vertical or concave. Hall described this as a gape in the valves which it appeared to be from his single specimen.

The relations of these shells appear to be wholly with the pterineoids, the conformation of the anterior parts indicating the structure of Mytilarca.

Localities. At Fruing's, Indian Cove and elsewhere along the Grande Grève coast. We have already noted the presence of this shell in the St Alban beds.

Leptodomus canadensis Billings

Leptodomus canadensis Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 54, pl. 5, fig. 1

Original description. Transversely elongate, oblong. Dorsal margin, as seen in the cast of the interior, nearly straight, gently concave, slightly the most elevated at the umbones. Ventral margin gently convex; a small portion at the anterior third concave; the posterior third ascending with a moderately convex curve. Anterior extremity slightly sinuated at about the mid-hight; below the sinus, a little projecting and narrowly rounded; nearly vertical above; rounded over the umbones. Posterior extremity with the most projecting point just above the mid-hight; gently rounded below; obliquely truncated above.

The shell is rather strongly convex, most prominent about the middle or a little in front thereof. The umbones are large, beaks incurved. From the anterior third of the ventral margin an obscure shallow depression in the surface ascends obliquely upwards and forwards, dying out on the umbo, before reaching the beak. The umbones are subcarinate on their upper and posterior edge. The dorsal margin is inflected, with some indications of a long narrow lunule.

Surface, as appears by the cast of the interior, with strong concentric undulations, three or four lines wide towards the posterior; narrower and deeper on the umbones.

Length, about two inches; hight at the umbones, ten lines; depth of a single valve, six lines.

This species is very rare in our collections from the Grande Grève limestones.

Localities. Grande Grève and Indian Cove.

Modiomorpha varia (Billings)

Plate 22, figures 1–5

See p. 115

Modiolopsis varia Billings. Palaeozoic Fossils, p. 56

This species was described without illustration and its locality was given as "between Cape Gaspe and Cape Rosier." We find on inspection of the originals, figures of which are here given, that they are from localities of the Grande Grève limestone; Indian Cove, Little Portage and Grande Grève. Similar shells we have found to be of frequent occurrence in the shore outcrops of the Forillon.

The species is very similar in type of outline and exterior to M. alta Conrad, a common form of the Hamilton fauna [*see* Hall, Pal. N. Y. v. 5, pt 1, pl. 37], and approaches some of the described forms from the earlier Devonic faunas of New York like M. ponderosa of the Onondaga

limestone and M. schoharie of the Schoharie grit though always smaller. It is depressed at the umbo with the beaks obscure or suppressed, has a broad and low umbonal ridge with a shallow and broad depression or sinus in front of it. The hinge line is relatively short and straight; the posterior curve broadly explanate; the lower margin contracting in front of the middle and rounding to a narrow anterior margin. The general expression of the valves is that of broadly convex and explanate posterior surface. Surface markings, sharp concentric striae.

Goniophora mediocris Billings

Plate 22, figures 6-8

Goniophora mediocris Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 50, fig. 21

Original description. Length of the cast of the interior about two inches; greatest hight (near the mid-length), one inch; base gently convex with an obscure sinus a little in front of the middle; hinge slightly ascending backwards, to a point just behind the mid-length. From this point the posterior margin descends, with a straight or gently concave slope, to the posterior angle, which is situated at about one third the whole hight of the shell. Beaks small, closely incurved, almost in contact with each other, at about one half the hight of the shell; below them the anterior extremity projects two or three lines. From the beak a strong sigmoid angulation extends to the posterior angle. The surface above this is gently concave, and below gently convex. A broad, shallow, barely perceptible depression extends from the beak to the ventral margin, which it reaches just behind the middle. Greatest depth of the valve a little in front of the middle. Depth of both valves at this point (in a specimen about two inches long) one inch.

Locality and formation. Gaspé: Gaspé limestone, no. 8.

This is a rare species and we figure the only example we have seen.

Locality. Lehuquets Cove, Forillon.

Goniophora tethys (Billings)

Plate 22, figures 14-16

Sanguinolites tethys Billings. *op. cit.* p. 50, pl. 4, fig. 5, 5a

Original description. Elongate; dorsal and ventral margins subparallel; anterior extremity rounded, most extended at about one third the hight; posterior extremity obliquely truncated; beaks at about one seventh the length of the shell from the anterior ends, closely appressed; a strong obtusely rounded convexity extends from the beaks to the ventral posterior angle. Length, three and one half inches; hight, about fifteen lines; depth of both valves, nine lines.

Only one specimen, an internal cast, of this speciès has been collected. The ventral margin is imperfect, but it appears to have been gently convex, with a slight sinuation just anterior to the mid-length. The hinge line is straight and two thirds the length of the shell, slightly elevated posteriorly. The slope of the posterior margin occupies about one third of the whole length. The posterior ventral angle, narrowly rounded or subacute. Above the diagonal convexity, which extends from the beak to the lower posterior angle, the sides are compressed or slightly concave. Below it they are gently convex, with a broad shallow concavity from the beak to the ventral margin.

The characters of the hinge line cannot be made out from this specimen. It seems however, to have had an external ligament. Just below the dorsal edge and parallel to it, there is an obscure groove in the cast, indicating a tooth or a ridge on the shell. Surface unknown.

Locality and formation. Grande Grève, Gaspé. No. 8.

We present figures of the original and another specimen of this species from Grande Grève.

Schizodus ventricosus (Billings)

Plate 23, figure 10

Anodontopsis ventricosa Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 55, fig. 24, 25

Original description. Strongly convex, ovate; hight about two thirds the length. Anterior extremity with the most projecting point at a little over one third of the hight, between which and the umbones the outline is gently concave. Ventral margin rather strongly convex, deepest a little in front of the middle, more abruptly rounded up to the anterior than to the posterior extremity. Umbones large, rounded; beaks closely incurved; hinge line straight; the anterior extremity situated at about two thirds the hight; thence sloping upwards and backwards to a point on the dorsal margin a little behind the mid-length of the shell. Dorsal outline most elevated at the umbones, between which and the extremity of the hinge line slightly concave. Posterior extremity most projecting at about the lower third; above this point obliquely truncated, ascending to the extremity of the hinge line with a gently convex slope.

Judging from the cast of the interior, the ligament in this species is external. The dorsal margin behind the umbones is sharp, slightly compressed, gently concave just below the edge.

Surface unknown.

Length of the best preserved specimen collected, eighteen lines; hight at the umbones, twelve lines; depth of both valves, ten lines.

We have identified our specimens with Billings's species though they are for the most part less convex and show more emphatically the aspect of Schizodus. All are internal casts and not well preserved.

Localities. Grande Grève and Indian Cove.

Nuculites sp.

Plate 24, figure 11

We have observed at Grande Grève a single well defined internal cast representing this genus but are reluctant to attempt a definition of its characters. It is apparently unlike the common species of the Gaspé sandstone and the genus is not found in the allied faunas of the Helderbergian and Oriskany.

Conocardium cuneus (Conrad)

Plate 23, figure 8

For description and illustrations *see* Hall, Palaeontology of New York. 1885. v. 5, pt 1, p. 409, pl. 67, fig. 1–32; pl. 68, fig. 1, 4–16; pl. 94, fig. 11, 12

This common and characteristic species of the Onondaga limestone and Schoharie grit of the Appalachian basin is present with well defined

characters in the Gaspé limestones, though it here appears to be a rare form.

Locality. Grande Grève.

BRACHIOPODA

Centronella glansfagea Hall

Plate 25, figures 1–4

Rhynchonella glansfagea Hall. N. Y. State Cab. Nat. Hist. 10th An. Rep't. 1857. p. 125, fig. 1–6

Centronella glansfagea Hall. Palaeontology of New York. 1867. 4: 399, pl. 61A, fig. 1–21, 25, 26

Centronella glansfagea Hall & Clarke. Palaeontology of New York. 1894. v. 8, pt 2, p. 268, fig. 180, pl. 79, fig. 1–14, 17, 21

A few specimens of this species have been found in the limestones of Grande Grève and show the characteristics both of exterior and interior. The species is common in the Onondaga limestone of New York and elsewhere and has been reported by Schuchert from the Oriskany (Decewville beds) of Ontario where these two faunas are commingled.

The presence of this species in the Grande Gréve fauna and the absence of the genus Oriskania which is so characteristic a member of the Glenerie and Becraft Oriskany leads us to note that while externally the difference in these shells is chiefly one of size, both sharing the boat shaped contour with arched and medially elevated ventral and flat or medially concave dorsal valve, there are more essential internal distinctions. Oriskania is progressed in many features of structure in its large and divided cardinal process and the thickening of other parts which are a concomitant both of individual and racial age, and there is a further distinction in the form of the loop, in Oriskania the descending branches being broader and blade like, approaching closely (so far as we have been able to make out from silicified specimens) the brachial apparatus of Megalanteris and Beachia.

Cryptonella (?) ellsi nov.

Plate 25, figures 8–10

This is a much more elongate shell than the preceding with relatively slender and projecting umbones and sloping cardinal margins. The beak of the ventral valve is arched but not incurved, the lateral slopes broad and excavated, bounded without by long cardinal ridges extending one half the length of the shell. The valves are about subequally convex but the ventral valve is flattened toward the anterior margin. Width of valve to length as 2 to 3.

Rare at Grande Grève.

Species name. Dr R. W. Ells, experienced expositor of the geology of Gaspé.

Cryptonella (?) fausta Clarke

Plate 25, figures 5-7

Cryptonella (?) fausta Clarke. N. Y. State Mus. Mem. 3. 1900. p. 38, pl. 5, fig. 1-8

Specimens which vary in outline from the original of this species only in the somewhat greater breadth of the pallial region occur occasionally. None show the brachial structure and hence the generic character remains uncertain.

Localities. C. ? fausta is known from the Oriskany of Becraft mountain and from Grande Grève and Indian Cove. It has not been observed in the deposits at Glenerie, N. Y.

Rensselaeria ovoides Eaton (sp.) var. **gaspensis** nov.

Plate 25, figures 11 23; plate 26, figures 1-5

Rensselaeria ovoides Billings. Logan's Geology of Canada. 1863. p.
Rensselaeria ovoides Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 41, pl. 3, fig. 7, a, b, 10, a

Mr Billings identified, without qualification or comment, this abundant and peculiar shell with Rensselaeria ovoides Eaton, describing it as follows:

The usual form of the larger specimens of this species is elongate ovate; sides nearly straight or gently convex as shown in fig. 7, 7a. The smaller individuals (fig. 10, 10a) are always wider in proportion to the length and more pointed in front than the larger. In the proportions, there is a gradual passage from specimens in which the width is equal to the length, or even a little greater, to those which the length is twice the width. The ventral valve is the most convex of the two, usually obscurely rounded, angular along the middle, with a gently convex slope towards the sides; a portion of the margin bent at nearly a right angle towards the opposite valve. The outline on a side view is most elevated about the mid-length or a little above; abruptly curved down over the umbo to the beak, more gently and uniformly arched to the front margin. Umbo moderate, rising one or two lines above that of the opposite valve; beak closely incurved down to and in contact with the dorsal umbo. The depth of this valve is sometimes nearly equal to its width. Dorsal valve moderately convex, most elevated along the median line where it is rounded angular, with a gentle convex, flat, or even slightly concave, slope towards the sides; a portion of the margin bent at nearly a right angle, as in the ventral valve. The umbo is only slightly prominent, the beak always concealed beneath the opposite beak.

In the young individuals, the angulation along the median line of both valves usually extends to the front margin; but, as the shell becomes larger, the anterior half or two thirds becomes uniformly depressed, convex, and the angulation disappears.

Surface with fine radiating striae, five to ten in the width of two lines. These striae are most distinct at the front margin, and become obscure or die out altogether above the mid-length of the shell. Sometimes the upper one third of the shell is quite smooth. The shell is also marked by a variable number of concentric wrinkles of growth, which give the outlines of the shell at all ages, and show how the same individual gradually changed from the broad to the narrow form as it increased in size. In general the specimens from the limestone are smoother than those from the sandstone.

Length of a full grown shell usually about two and a half inches; width, twelve to fifteen lines. Sometimes the depth of the two valves together is greater than the width. The shell is often more or less compressed laterally, and exhibits distortions, which are natural, or not the result of pressure.

Analyzed as to exterior characters this shell is a miniature of the great Renss. ovoides of the New York Oriskany, varying in proportion, dimensions, outline and convexity, much as that shell does, that is, frequently high shouldered and broad across the umbones, rarely broadest in the pallial region, often with lateral margins vertical or slightly introverted specially about the umbones, but as often without this character, usually with the ventral valve medially elevated, and finally with a diversity in the character of surface striation which is due to the fact that the fine striae of early age maintain their simplicity but increase in width without additions, to that in old shells or progressed stages of relatively young shells where the surface may seem to be coarsely marked. On the other hand the shells are characterized by a prevailing narrow elongate-linguate outline with parallel lateral margins for a great part of their length. On the interior there are a few notable and perhaps no constant differences, whether in respect to structure or musculature or cardinal plate. It is however here important to bring forward the fact which the writer has already expressed with some emphasis, that as between the genera Rensselaeria (as based on the type species R. ovoides) and its chronologic successor Amphigenia, there is a distinction solely in one structural point. In form and nearly every detail of outline, surface and contour, in musculature, cardinal arrangement, brachial structure so far as known and in intimate shell structure they are homogenic. In Amphigenia however the converging dental plates do not reach the bottom of the valve but first unite and the resultant spondylium is supported on a short median vertical septum. In Rensselaeria the plates converging, fail to unite but meet the inner wall of the shell leaving between them a narrow surface, which is in effect the base of the spondylium. In this special feature which can hardly be accredited with high value as an anatomical differential, there is a definite indication of progress. The Gaspé shells show how frail is this conventional distinction. The convergence of the dental plates leaves only a very narrow space between and quite frequently they come together at the very surface of the shell wall. Even a single vertical septum may develop in the later forms of the Gaspé sandstone as shown in our figures. It is natural to compare the small elongate shells from Gaspé with Hall's Rensselaeria marylandica from the Cumberland Oriskany. They are shells of the same proportions but in respect to development of the dental lamellae the latter is rather less progressed than Renss. ovoides.

In view of the evidence presented by these Gaspé shells it seems to us necessary to regard Amphigenia essentially synonymous with Rensselaeria

and indicating as we have said a progressed condition of one feature only. Rensselaeria has many specific expressions and among the forms now referred to it are several more significant departures than is presented by Amphigenia elongata.

Localities. Rensselaeria ovoides var. gaspensis is very common at Grande Grève at several localities and occurs also without variation except as indicated, in the Gaspé sandstones on the Portage road, Gaspé Basin. At Percé the species is less common and often striking for its great elongation of form.

Rensselaeria sp. ?

Plate 26, figures 6, 7

There are a few specimens of Rensselaeria which differ from the others in their very much coarser plication and in these the dorsal valve is broadly and evenly flattened or depressed convex without the characteristic median elevation of Renss. gaspensis. These are departures so wide from the expression of the last named that they seem to indicate a distinct form. The specimens are from Grande Grève.

Beachia amplexa nov.

Plate 26, figures 14–17

Beachia suessana and Megalanteris ovalis Hall are two very similar brachiopods in the Oriskany fauna. Whenever a considerable number of specimens of both is available, those of the latter are, as Professor Hall noted in 1859, generally larger, more compressed and proportionally broader. Further differentials are found in the more broadly rounded anterior margin of the latter, the absence of introverted margins except at the cardinal shoulders and a low radial surface striation, coarser but more obscure than in Beachia, and restricted to the marginal regions rather than covering the entire shell as in that genus.[1] The critical distinction in the genera however is an internal one based on the structure of the cardinal process. These features have been elaborately illustrated by Hall & Clarke[2] whose figures show that in Beachia suessana this process is distinctly rensselaeroid and consists of two flattened subtriangular plates fused medially and thickened or cushion shaped at the sides with a median foramen beneath the beak which is closed only by excessive calcification. In Megalanteris ovalis this cardinal process is stout, subcylindrical, doubly grooved at the extremity and rising from a flat hinge plate, as though in effect the single cylindrical process were superinduced on the hinge plate of a Beachia.

[1] Billings's figure 471a of Renss. ovalis given on page 962 of the *Geology of Canada*, is not that species but its size, form and surface striation indicate that it is the form subsequently described by Hall & Clarke as Renss. cayuga.

[2] Pal. N. Y. 1894. v. 8, pt 2, pl. 77.

The shells from the Grande Grève fauna which present such characters as those specified are wholesome looking individuals of the aspect of Megalanteris, averaging larger than specimens of either Beachia suessana or Megal. ovalis and yet they have a predominant similarity to the latter. They combine however in most instructive manner the characters of both these species and genera, and we endeavor to express this relation by comparison in tabulated form with the distinctive characters of each, those of the Grande Grève shell being printed in italics.

Beachia suessana	Megalanteris ovalis
Outline elongate	*Outline subcircular*
Margins introverted deeply at side and slightly in front	*Margins introverted but slightly at the cardinal shoulders*
Surface finely striated	*Surface smooth*
	Coarse internal striations interlocking at front margins
Shell punctate	*Inner shell layer punctate*
Cardinal plate composed of two cushioned crural bases cemented medially. Foramen usually open except in old stages. No cardinal process	Cardinal plate flat and thickened bearing a stout cylindrical process doubly grooved at the summit. Foramen lost
Ventral adductor scar shallow and faintly defined	*Ventral adductor scar deep, long, sharply divided*
No vascular markings	*Vascular markings*
Dorsal muscle scar extremely faint	*Dorsal muscle scar well defined and clearly divided*

We may fairly summarize the above by the statement that the Grande Grève shells essentially agree with Megalanteris ovalis in all respects save that which has been regarded as the basis of the generic distinction, namely the structure of the hinge plate. Hence the shells are to be referred to Beachia rather than to Megalanteris.

This statement however obscures with words the actual relations. If we analyze the structural features in order of ontogenic values it is evident that Meg. ovalis simply represents a greatly progressed condition of which Beachia suessana is a primitive expression and the Grande Grève shell an intermediate stage. So far as the last named is concerned this condition is evinced in a usually greater thickening of the hinge plate than prevails in Beachia, and a less strong development of the muscular scars than in Meg. ovalis.

Beachia suessana is an Oriskany species of the Cumberland basin, Maryland. The specimen which has been identified therewith in the Oriskany at Rondout is familiar to the writer but there is no particular reason for assigning it to Beachia rather than to Megalanteris. The simplest expression of these shells is therefore the most southerly.

For the sake of an expression therefore the term applied to this species will serve. It is evident that the generic distinction between Beachia and Megalanteris is a fugitive one and of little value. Probably it will be found wise to withdraw the former term altogether and express the relations here indicated by specific terms which are even then too exacting. It is not a matter of record that these species have the same character of brachial processes but specimens are before me from the Glenerie Oriskany which show this to be the case.

Localities. Beachia amplexa is specially common in the purer layers on Dolbel brook associated with Hipparionyx proximus and Rensselaeria. It is not usually found in the shore outcrops. At Percé Rock it is not uncommon.

Megalanteris thunei nov.

Plate 26, figures 8-13; plate 27, figures 7-15

Shells having the aspect of M. ovalis often with more convex ventral valve are distinguished chiefly by numerous generally fine radial plications covering the entire surface except the umbones. This feature is highly developed and is not connected by gradation with the smooth exterior of M. ovalis. The internal markings are essentially as in the other species, the ventral adductor scar being even more conspicuous, the cardinal plate less developed.

Localities. From the shore outcrops at Grande Grève and from Percé Rock.

Species name. Exuperius de Thune, Recollet missioner at Percé, 1670.

Camarotoechia cf. **ramsayi** Hall

Plate 28, figure 9

See Rhynchonella ramsayi Hall. Palaeontology of New York. 1859. 3:446, pl. 101A, fig. 7, 8, a, b

We find in the Gaspé material a single ventral valve characterized by its elongate form, broad anteriorly, the absence of median sinus, though the anterior margin is produced medially and there are two low longitudinal depressions which bring the median part into low relief, an effect sometimes shown on immature forms of the species here referred to Plethorhyncha pliopleura; the surface plications are sharp and rather coarse but rapidly

duplicate. Before duplication begins there are 25 of these plications and at the front margin about double that number. The muscular scar of this valve is particularly small. Rhynchonella ramsayi is a shell of these proportions and degree of plication with a similarly obscure median sinus; apparently the plications are, however, simple instead of duplicate. It is one of the rare forms from the Oriskany of Cumberland, Md.

Locality. The single specimen is from Grande Grève.

Camarotoechia excellens (Billings)

Plate 28, figure 18

Rhynchonella excellens Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 36, fig. 17, 18

Original description. Subcircular or obscurely subpentagonal; slope on each side of the beak concave; sides broadly and uniformly rounded; front margin, with about one third the width of the middle, either straight or gently concave. Greatest width about the mid-length or a little in front thereof; width about one sixth or one fifth greater than the length. Ventral valve moderately convex; most elevated at about one third the length from the beak; mesial sinus, at the front margin, about one third the whole width of the shell; flat in the middle or uniformly concave, deeply indenting the edge of the dorsal valve [fig. 18], but becoming nearly obsolete at about one fourth the length from the margin, and disappearing entirely at about half the length of the valve. Umbo small; beak closely incurved down to the umbo of the dorsal valve. Dorsal valve somewhat more strongly convex than the ventral; the outline on a side view nearly parallel with the plane of the lateral margin for about two thirds the length from the front, then abruptly curved down to the beak. Owing to the depth of the sinus the front margin, on a side view, is nearly squarely truncated for about half the depth of both valves. The mesial elevation is either uniformly convex or a little flattened in the middle, usually gently sloping but sometimes abruptly elevated at the sides of the margin. It becomes obsolete at one half the length of the shell.

Surface with thirty to forty rounded or subangular ribs (counted at the margin). Some of these on the mesial fold of the dorsal valve, and in the sinus of the ventral valve, are undivided throughout their whole length. On each side of the fold and sinus the ribs are bifurcated at various points between the beak and front margin.

In one specimen, from which the shell has been partially removed, the cast of the interior of the dorsal valve shows a mesial septum extending about one third of the length from the beak.

Length of a specimen of average size, thirteen lines; width, sixteen lines; depth of both valves, nine lines.

This species seems to be rare, as only about a dozen specimens have been collected.

This is a well defined species of which we have observed but a single typical example.

Locality. Grande Grève. Billings's specimens are from Indian Cove.

Camarotoechia dryope (Billings)

Plate 28, figure 2

Rhynchonella dryope Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 37, pl. 3A, fig. 1, a–c

Camarotoechia dryope Clarke. N. Y. State Mus. Mem. 3. 1900. p. 41, pl. 5, fig. 20, 21

Original description. Subcircular or subpentagonal; apical angle varying from about 95° in the smaller specimens to 130° in the larger. Slope on each side of the beak concave or nearly straight for two or three lines, then slightly convex; sides rounded; front margin, with a portion in the middle about equal to one third the width, either straight or slightly concave. In the larger specimens the greatest width is about the mid-length; in the smaller somewhat nearer the front. Width of a large specimen, thirteen lines; length, eleven lines; depth of both valves near the front margin, eight lines. Ventral valve varying from slightly to moderately convex; a portion on each side of the mesial sinus flat or even slightly concave near the front margin; umbo narrow; beak incurved down to the umbo of the dorsal valve. The mesial depression is rather less than one third of the whole width, indenting the opposite valve, at the margin, to an extent equal to the depth of both valves or nearly so. From the margin it becomes gradually more shallow with an uniform curve until it becomes obsolete at about the mid-length of the shell, or a little above; a rib on each side slightly longer than the others extends nearly to the beak, in some specimens. There are three ribs only in the depression, in all the specimens collected. The rib on each side presents a large flat, slightly convex or slightly concave face, sloping upwards, and more or less inclined outwards from the bottom of the depression.

The dorsal valve is rather strongly convex. On a side view [fig. 1b] the front margin is nearly squarely truncated; the outline, from the most elevated point at the front, is sometimes nearly straight for one third or one half the length, but in general it is gently convex for that distance and then becomes more or less abruptly curved down to the beak of the ventral valve. The umbo is of moderate size, rounded, abruptly elevated from the beak in large specimens, sometimes with a very faint mesial depression for two or three lines. The mesial fold is strongly elevated at the front margin but dies out at the mid-length, or a little above.

Surface with strong subangular ribs; four on the mesial fold and three in the mesial depression. On each side of the mesial fold and depression there are usually five or six ribs in the smaller and medium sized specimens, and seven, eight or nine in the larger. The most common number is six on each side.

The ribs are more strongly curved outwards towards their extremities than is represented in the above figures.

Though we have observed the existence of this species in the Oriskany of Columbia county, our collections at Gaspé show only a small shell that can be regarded identical therewith. This is the more singular as it is not regarded by Billings as a specially rare form. His specimens were collected by Robert Bell at Grande Grève.

Uncinulus mutabilis Hall

Plate 28, figures 3-8

Rhynchonella mutabilis Hall. N. Y. State Cab. Nat. Hist. 10th An. Rep't. 1857. p. 66, fig. 1-3
Rhynchonella mutabilis Hall. Palaeontology of New York. 1859. 3: 225, pl. 29, fig. 4; pl. 30, fig. 1, 2
Uncinulus mutabilis Hall & Clarke. Palaeontology of New York. 1894. v. 8, pt 2, p. 199, pl. 58, fig. 22-25

With this species we identify provisionally a subspherical shell, which apparently agrees in all respects with typical forms from the Helderbergian of New York. These have shallow ventral and highly concave dorsal valves, low flat or depressed plications with narrow interspaces, the number of the plications varying considerably, but generally from 20 to 28, usually simple, occasionally bifurcating, those on fold and sinus being 4-6. The characters of the genus are well defined, the abruptly upturned margins of the ventral valve, the sharply interlocking ribs along the commissures and the fine zigzag concentric striation on the ribs about the margin, not interrupted by a median line and the highly developed elevated cardinal plate and bifurcate, grooved cardinal process. This is the most abundant of the Rhynchonellas we have observed in the fauna.

Locality. On the shore at Grande Grève.

Plethorhyncha barrandii Hall

Plate 28, figures 16, 17

Rhynchonella barrandei Hall. N. Y. State Cab. Nat. Hist. 10th An. Rep't. 1857. p. 82, fig. 1-3; p. 84, fig. 4
Rhynchonella barrandei Hall. Palaeontology of New York. 1859. 3: 442, pl. 103, fig. 3-8
Plethorhyncha barrandei Hall & Clarke. Palaeontology of New York. 1894. v. 8, pt 2, p. 191

This shell characterized by the large size and sharp, strong, usually simple and in respect to its associates, sparse plications, is represented in our collections from Gaspé by a single well defined ventral valve from Grande Grève.

Plethorhyncha pliopleura (Conrad)

Plate 28, figures 10-15

Atrypa pleiopleura Conrad. N. Y. Geol. Sur. 5th An. Rep't. 1841. p. 55
Rhynchonella pleiopleura Hall. Palaeontology of New York. 1859. 3: 440, pl. 102, fig. 3, 4
Plethorhyncha pliopleura Hall & Clarke. Palaeontology of New York. 1894. v. 8, pt 2, p. 191

The large Oriskany Rhynchonellas which are of the type of Plethorhyncha vary greatly in exterior expression on account of different degrees

of development of fold and sinus, rapidity of bifurcation of plications and other minor and fugitive features. The material which was described by Hall in *Palaeontology of New York*, volume 3, so far as it was derived from the New York formation was not specially good and this is probably the reason of the endeavor to establish so many specific distinctions therein. With the high grade material which has now been derived from the Glenerie deposits it is not easy to find much basis for most of the distinctions then made (R. pleiopleura, multistriata, principalis, oblata, fitchana). There are two pretty well defined specific types one with coarse angular, few and simple plications, viz, R. barrandei and the other with the plications more numerous and rapidly bifurcating. Billings identified with R. pliopleura the large shells from Gaspé and we are disposed to continue this name, though specimens of just this type are not familiar to us in the New York Oriskany. These Gaspé shells are large and fine examples with highly convex dorsal valves, specially full at the umbo, rather shallow ventrals, little if any trace of fold or sinus on the first half of the valves and both broad and not abruptly flexed at the anterior margin. In immature stages the shell has the aspect of R. oblata Hall. The surface striae are very numerous (100–150), much in excess of those in the New York shells which rarely run above 70 and these are increased by the rapid bifurcation with growth.

There is so much uncertainty at present in regard to the specific values in this group of shells that, though recognizing the departure in the shells of the Grande Grève limestones we are disposed to retain for them the term applied by Billings.

Dimensions. Normal adults attain a size of about 55 mm in length and 50 mm in width.

Localities. The best and most abundant specimens have been found in Dolbel brook and on the coast at Lehuquet's.

Eatonia peculiaris Conrad

Plate 29, figures 1–13

Atrypa peculiaris Conrad. N. Y. Geol. Sur. 5th An. Rep't. 1841. p. 56

Eatonia peculiaris Hall. Palaeontology of New York. 1859. 3: 244, pl. 38, fig. 21–26; pl. 51, fig. 2; pl. 101, fig. 2; plate 101A, fig. 1

Eatonia peculiaris Billings. Palaeozoic Fossils. 1874. v. 1, pt 2, p. 40, pl. 3A, fig. 2, a–c

Eatonia peculiaris Hall & Clarke. Palaeontology of New York. 1894. v. 8, pt 2, pl. 61, fig. 17–26

This is the most abundant of all fossils in the Grande Grève limestones on the Forillon. Nearly all the fossiliferous layers teem with it and its profusion is in marked contrast to its occurrence elsewhere. In identifying it with the New York Oriskany species to which Conrad gave the above

name it is necessary to state the value which we assign to this term. After the introduction of Conrad's name Vanuxem applied the term Atrypa singularis to a species from the Helderbergian fauna and in volume 3 of the *Palaeontology of New York* Professor Hall recognized both species, stating that he had found both in the Helderbergian but only A. (Eatonia) peculiaris in the Oriskany. Hall admitted the very close similarity in these species but found the distinguishing difference in the broader outline of E. singularis, the more elongate form of E. pecularis. He said:

This species was regarded by Mr Conrad as restricted to the Oriskany sandstone; but in the course of many years' collections, a considerable number of specimens have been found in the limestone of the Lower Helderberg group. In its surface characters, it scarcely differs from the preceding species; the form, however, is always more or less distinctly ovate; the mesial sinus less deeply and less distinctly pronounced; while the mesial fold of the opposite valve is less abrupt, and does not extend so nearly to the beak of the valve; the margins of the valves, and particularly of the ventral valve, are distinctly inflected along the cardinal slopes, giving an undefined oval area on each side below the beaks. The crenulations in front are always visible in well preserved specimens, and these sometimes produce a slight undulation or plication of the exterior near the margins.

While these differences are marked in the New York shells to such a degree that they may always be observed, yet in the New York Oriskany there are shells both of the broad and of the elongate type. In view of the fact that no other distinction has been admitted and that none are palpable it is clear that the shells have been artificially separated. Yet there is a certain value attaching to the difference noted. The broad form prevails in Helderbergian faunas of New York, it is about equally present with the elongate form in the New York Oriskany while the latter is the prevalent if not the exclusive shell in the Cumberland (Md.) Oriskany. In Gaspé the shells are all of the broad or singularis type, retaining throughout the fine sgraffito radial ornament of the shell and the usual predominant median stria; they are moreover a wholesome vigorous race attaining commonly a size which is noteworthy in comparison with the New York and Maryland shells. They are strongly contrasted with the small and elongate New York shells of E. peculiaris, with their narrow tongue-shaped extension of the sinus. This large type of shell is rarely present in the Glenerie Oriskany. Myriads of smaller shells compose some of the rock layers, but between large and small there are no specific distinctions, and none that are not easily overpassed between these and the most extreme forms of E. peculiaris. These relations are thus expressed:

Eatonia peculiaris

	Cumberland	Eastern New York	Gaspé
Long form - - - - - - - -	x	x	
Broad form - - - - - - -		x	x

Dimensions. Large examples of the species measure 28 mm in length, 27 mm in width. The small shells average about 16–18 mm in length and in width.

Localities. Everywhere in the coast exposures on the north shore of Gaspé Bay. In the middle and upper layers of the formation. Absent from Percé Rock. The species is present in the lower beds of the Gaspé sandstone, but it is very rare.

Leptocoelia flabellites (Conrad)

Plate 29, figures 23–30

Atrypa flabellites Conrad. Geol. Sur. N. Y. 5th An. Rep't. 1841. p. 55
Leptocoelia flabellites Hall. Palaeontology of New York. 1859. 3: 449, pl. 103B, fig. 1; pl. 106, fig. 1
Leptocoelia flabellites Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 42, pl. 3, fig. 5a, b, 6a
Leptocoelia flabellites Hall & Clarke. Palaeontology of New York. v. 8, pt 2, 1895, p. 137, pl. 53, fig. 40–46, 53
For additional references see Schuchert (under Anoplotheca), Synopsis of American Fossil Brachiopoda, 1897.

This world-wide early Devonic species is very abundant in the Gaspé sandstone where it covers entire surfaces of layers and is the most profuse in individuals of all its species. It is much less abundant in the limestones. In both it maintains the characteristics of the shell in New York, Cumberland and elsewhere, though there are at certain layers of the limestones very large specimens attaining a size not elsewhere noted. Otherwise dependable differences are not observable.

It is needless to enlarge upon the distribution of this species further than to note the early record of its presence in the Falkland Islands by Morris & Sharpe under the name Atrypa palmata. Salter described it as Orthis aymara from various localities in the Bolivian Andes and Ulrich has cited a large number of additional occurrences. It occurs at Matto Grosso, Brazil, and in the early Devonic of South Africa and the Cape; in the United States at Cumberland, Md., throughout the New York Oriskany localities where fossiliferous, and in Union county, Illinois. It also rises into the Onondaga fauna in Ontario (Decewville beds).

Localities. Occasionally in the limestones about Grande Grève. Very abundant at Percé. Very common in the Gaspé sandstones at Gaspé Basin.

Coelospira concava Hall

Plate 29, figures 19–22

Leptocoelia concava Hall. Palaeontology of New York. 1859. 3: 245, pl. 38, fig. 1–7
Coelospira concava Clarke. N. Y. State Mus. Mem. 3. 1900. p. 42, pl. 5, fig. 23–26

This species is rare, only a few specimens of the valves having been found among the etchings. It is a common form in the Helderbergian fauna of New York and likewise in the Oriskany of Becraft mountain and Glenerie.

Locality. Grande Grève.

Nucleospira cf. **ventricosa** Hall

See Palaeontology of New York. 1859. 3: 220, pl. 14, fig. 1; pl. 28B, fig. 2–9

This is one of the rarest of the brachiopods of the fauna and has been observed only in imperfect specimens. Nucleospira ventricosa is a species of the Helderbergian fauna of New York and Maryland.

Localities. In the middle limestones at Grand Grève.

Rhynchospira or **Retzia**

A single specimen shows the presence in the fauna of spire-bearers of this type, the example in hand having a noticeable similarity to Rhynchospira formosa Hall of the Helderbergian.

Locality. Grande Grève.

Meristella champlaini nov.

Plate 30, figures 1–20

Prob. Athyris laevis Billings. Logan's Geology of Canada. 1863. p. 393
Athyris (Merista) arcuata Billings. Palaeozoic Fossils. 1874. v. 1, pt 2, pl. 3, fig. 9, a, b

Specimens of Meristella are among the commonest fossils in the Grande Grève limestones. Adult forms share with immature individuals a well defined habit which can be readily expressed in words but not so readily discriminated from the known characters of one and another of the many species of the genus which have already been described from the faunas of about this age. We can not fully identify the commonest of these shells occurring on the Forillon with any of the described species but can express the differentials best in terms of such species.

Into immediate comparison with these shells, then, we bring the following known forms: Meristella laevis, M. arcuata, M. subquadrata of the Helderbergian fauna; M. lata and M. vascularia of the Oriskany fauna. Comparisons therewith are introduced *seratim*.

Meristella laevis Vanuxem (Atrypa laevis Vanux. Rep't 3d Dist. N. Y. 1842, p. 120, fig. 2; Merista laevis Hall, Pal. N. Y. 1859, 3:247, pl. 39, fig. 3, 4; Meristella laevis Hall & Clarke, Pal. N. Y. 1894, v. 8, pt 2, pl. 43, fig. 3–6) is a rather elongate shell with long cardinal slopes making a relatively small angle with each other. Both valves are moderately and subequally convex, the ventral valve faintly sinuate medially, in old stages with a broad and rather short linguate extension on the front margin which, when slightly broken, as in most of Hall's figures, gives the front a subtruncate appearance. The dorsal valve has a broadly defined median ridge in all stages, but obscure near the margin in the adult. On the interior there is seldom any trace of vascular impressions departing from the muscular area.

Meristella champlaini ordinarily has less sloping cardinal margins and it is uniformly a proportionally broader shell. The convexity of the valves is persistently greater and specially so in late stages. Like M. laevis it carries a medial ventral sinus and a dorsal median ridge with depressed lateral slopes, but the linguate extension at the margin is greater. On the interior the vascular markings are highly developed.

Meristella arcuata Hall [*see* Pal. N. Y. 1859, 3:249, pl. 41, fig. 1a–t; Hall & Clarke, *idem*. 1894, v. 8, pt 2, pl. 43, fig. 1, 2; pl. 44, fig. 5] has a much larger umbonal angle than M. laevis and this is well expressed in M. champlaini. It likewise has the deeper valves of the latter, the ventral being specially curved at the umbo and arched at the beak. Here too we mark the deep lingua on the front margin as large or larger than in the Grande Grève shell. Differences in the two species are obscure but on the whole M. arcuata is less elongate, less sharply ridged on the dorsal valve and the interiors are without vascular markings.

Meristella subquadrata Hall [*see* Pal. N. Y. 1859, 3:249, pl. 40, fig. 3] expresses a condition in which the form of the shell is squared by the truncation (casual?) of the antelateral margins, making the median dorsal ridge quite prominent, a condition which is sometimes approached accidentally by M. champlaini.

Meristella lata Hall [Pal. N. Y. 1859, 3:431, pl. 101, fig. 3a–w], an Oriskany shell, differs from M. arcuata chiefly in size and the tendency to acquire a breadth unusual to that species. The prolongation of the anterior margin and the depression of the ventral umbo are also distinctive features and in both of these respects the shell is not the same as that in hand.

Meristella vascularia (described as M. ? vascularia Clarke,

N. Y. State Mus. Mem. 3, 1900, p. 45, pl. 6, fig. 12–14) comprises large shells with the proportions of M. lata but having the pedicle scar greatly developed and bounded by high dental plates, and the large adductor scar common to all these species obscured almost to obliteration by the pallial ridges and sinuses. The latter are here much more highly developed than in M. champlaini where the muscle scar suffers no obscuration therefrom.

Meristella champlaini is the designation which, in view of the peculiarities mentioned, we propose for this Grande Grève shell. It serves to express the fact that these shells share the features of a series of essentially contemporaneous forms in the American province and at the same time combines these in such a way that, considered ontogenetically, it is always distinguishable from them, while on the whole most nearly allied to the later expressions in the Oriskany sandstone.

Localities. At nearly all the higher outcrops along the coast at Grande Grève and Indian Cove.

Species name. Samuel Champlain.

Meristella lata Hall (*op. cit.*)

Plate 30, figures 21–26

Very rarely among the Meristellas at Grande Grève but abundantly at Percé occur shells characterized by their broad backed, depressed ventral valves, with low broad umbo incurved at the beak, sharply defined cardinal ridges below which the surface is concave to the hinge. These are in complete agreement with the Oriskany species M. lata except as to size. At Percé the individuals are uniformly small, but the same type is larger on the Forillon.

Localities. Rare at Grande Grève and Indian Cove; common in Percé rock.

Spirifer murchisoni Castelnau

Plate 32, figures 1–10

Spirifer murchisoni Castelnau. Essai sur le syst. silur. de l'Amer. septentr. 1843. p. 41, pl. 12, fig. 1, 2

Spirifer arrectus Hall. Palaeontology of New York. 1859. 3: 422, pl. 97, fig. 1, 2

Spirifer murchisoni Clarke. N. Y. State Mus. Mem. 3. 1901. p. 46, pl. 6, fig. 26–30

This species, everywhere abundant in Oriskany outcrops, is the commonest of the Spirifers in the Gaspé limestones. There are no essential particulars in which the shell differs from its expression in the more southerly formation but at the same time there are two pretty well defined differences evident. The more prevalent of these are displayed in shells

with broadly expanded, regularly curving sides on which the median sinus is low, with a flattened bottom and the fold correspondingly depressed; the lateral slopes bear eight or nine ribs with three or two indistinct ones besides near the cardinal angles; these ribs are regularly rounded and the intervening grooves narrow and shallow. Distinguished from these are individuals with deeper sinus having more angular slopes and making an elevated and acute fold on the dorsal valve. The plications are few, six, with traces of two or three others, are stout, with angular and deep grooves. The internal casts of these shells are characteristic, the ribs appearing quite angular and the muscle scar of the ventral valve very much more conspicuous than in the other expression. Hall made no distinction among the New York shells of this species but the variation indicated seems to be as well defined in one province as in the other. Most of the specimens figured in *Palaeontology of New York*, *ut. cit.* are of the latter type but the other expression is well shown in figures 1e and 1f.

In Museum memoir 3 [1901] I expressed the view that these differences which had been in a measure indicated by Scupin[1] were of fugitive value but the evidence derived from the Gaspé shells seems to indicate their stability and persistence. Dr Scupin suggested that the term Sp. arrectus (= murchisoni) be restricted to the forms with few and strong fold and sinus, that is, our second type, and that the other was identical with Sp. antarcticus Morris & Sharpe, collected by Darwin from the Falkland islands. This he proposed to call var. antarcticus and to include with it S. chuquisaca Ulrich (Bolivia), S. orbignyi Morris & Sharpe (Falkland islands) and S. capensis v. Buch (Cape Colony).

Localities. Common in many of the outcrops and along the shore at Grande Grève and Lehuquet's; rarer in the Percé Rock.

Spirifer cyclopterus Hall

Plate 32, figures 14–21

Spirifer cyclopterus Hall. Palaeontology of New York. 1859. 3: 199, pl. 25, fig. 1a–2

Spirifer cycloptera Billings. Palaeozoic Fossils. v. 2, pt 1, 1874. p. 48, pl. 3A, fig. 4a–c

The shells Billings referred to this species seem to show no characters which would separate them from the Helderbergian form. The species is not common on the Forillon. Billings reports Grande Grève and Indian Cove. It also occurs at Percé. We have here figured Billings's original specimens.

[1] Zeitschr. der deutsch. geol. Gesellsch. 1899. 50: 462.

Spirifer arenosus (Conrad)

Plate 33, figures 1–10

For full description and figures see Palaentology of New York, 1859, 3: 425 pl. 98–100; v. 8, pt. 2, 1894, pl. 29, fig. 1–4; pl. 30, fig. 3–7

This well known and characteristic Oriskany species which occurs in its best development in the sandy deposits of central New York is represented in the Grande Grève limestones by shells which occasionally attain considerable dimensions. They are characteristic throughout, varying in the degree of plication of fold and sinus and lateral slopes as do the typical forms. They carry the flattened ribs with narrow interspaces and the very fine radial lineation which is noted in N. Y. State Museum memoir 3 [p. 46][1] as a species character. Seldom in the Gaspé specimens is the sinus deep or the fold high, nor does the large muscular scar of the ventral valve make as conspicuous an effect on the internal cast as on the heavy shelled forms of New York, but the latter is a feature dependent on gerontic growth. The plications of the fold and sinus may at times be obscure but this seems to be due largely to condition of retention.

The shell is not among the commoner forms of Spirifer on the Forillon but abounds at Percé.

Localities. In division 2 at Grande Grève and Indian Cove and on Dolbel brook at the base of the series. Much more abundant at Percé Rock.

Spirifer arenosus Conrad var. **unicus** Hall

Plate 33, figure 11

Spirifera unica Hall. Palaeontology of New York. 1865. 4: 203, pl. 30, fig. 21
Spirifer superbus Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 45, pl. 3A, fig. 3, a, b
Spirifer billingsanus Schuchert. U. S. Geol. Sur. Bul. 87. 1897. p. 406

Spirifera unica was described by Hall from a single ventral valve derived from the Onondaga limestone of Erie county. It was characterized by the sharp and angular deflection of the sinus, the relatively numerous plications which are rounded or subangular rather than flattened by the regularity of the plication on the sinus and the single median plication more prominent than the rest. Professor Hall also noted the presence of fine radial lines on the surface of the plications.

Billings's single fine specimen of S. superbus was so angulated on the margin that it would stand upright when placed thereon. It was further characterized by plications similar in form and number specially the stronger

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[1] In his description of Sp. unicus [Pal. N. Y. 4: 204] Hall mentions not having observed these fine lines in Sp. arenosus, but they are always present when the surface is clearly retained.

one in the axial line. Hall & Clarke [Palaeontology of New York, 1894, v. 8, pt 2, pl. 30, fig. 8] referred S. unicus to S. arenosus, but there is on this shell and that which served as the type of S. superbus a concordance of minor differentials not seen in the typical forms of S. arenosus of the New York Oriskany nor in the representatives of the species in the Grande Grève limestones.

We have observed only three examples of this type in the latter, and none so good as Billings's specimen but they are all at once distinguishable from their associates by the features mentioned.

Localities. In the upper beds at Grande Grève and Indian Cove.

Spirifer fimbriatus (Conrad)

Plate 32, figures 11–13

Delthyris fimbriatus Conrad. Acad. Nat. Sci. Phila. Jour. 1842. 8:263
Spirifer fimbriatus Hall. Palaeontology of New York. 1867. 4:214, pl. 33, fig. 1–11

It is no light task to determine specific distinctions, alleged and actual, among the fimbriate-plicate Spirifers of this particular stage in the history of the genus in the ordinary state of their preservation. Spirifer cyclopterus, S. fimbriatus, S. tribulis, S. murchisoni and some others are such forms separated by distinctions which at times seem quite conventional and yet each is fortified in typical expression by the sum of its characters. The presence of Sprifer fimbriatus (the type of which is a Hamilton shell) in the Oriskany was indicated by Hall in the work cited wherein a small fragment of the shell was figured. The species proves to be common in excellent preservation in the deposits at Glenerie, N. Y. and differs from the later expressions of the species only in the stronger development of the plications. The history of the species as its limitations are now drawn seems to involve obsolescence almost to extinction of the plications and this is due rather to an arrest of development in later form than a distinct assumption of senile characters for in the earliest Oriskany shells the plications are obscure in the umbonal parts but become increasingly prominent with individual growth.

Billings seems to have regarded the Gaspé representatives of these shells as Sp. cyclopterus [*loc. cit.* p. 48, pl. 3A, fig. 4, 4a] and to have intended the same by the term Sp. crispatus used in Logan's *Geology of Canada*, page 392.

The Gaspé shells bear distinct similarity to Sp. tribulis which is so closely allied to Sp. cyclopterus of the Helderbergian that Hall suggested the latter might prove only a late representative of the former. There are differences however. Spirifer tribulis is a more extended shell with sharper plications and less equally convex and rounded valves

than S. cyclopterus, while the latter differs from S. fimbriatus chiefly in respect to the sharpness of plication and probably also in the character of fimbriation for in S. fimbriatus the spinules are double. The Gaspé specimens are in harmony with the Glenerie Oriskany specimens in respect to degree of plication.

Localities. Grande Grève, Indian Cove and Percé.

Spirifer raricosta (Conrad)

Plate 32, figures 22, 23

Delthyris raricosta Conrad. Acad. Nat. Sci. Phila. Jour. 1842. 8: 262, pl. 14, fig. 18

Spirifer raricosta Hall. Palaeontology of New York. 1867. 4: 192, pl. 27, fig. 30–34; pl. 30, fig. 1–9

Spirifer raricosta Billings. Palaeozoic Fossils. *op. cit.* p. 47, pl. 3A, fig. 5 a–b

This species in the Appalachian province pertains to the Schoharie grit and Onondaga limestone. At Grande Grève it is rare and I have seen only the specimens figured by Mr Billings, which are quite typical in the sparse and coarse plications though nothing is left of the surface ornament. The contour of the shell is qualified by compression. The species may be regarded as very rare in this fauna.

Spirifer plicatus (Weller)

Plate 31, figures 1–17

Metaplasia plicata Weller. Geol. Sur. N. J. Rep't on Paleontol. v. 3; The Paleozoic Faunas. 1903. p. 356, pl. 48, fig. 7–12

This species described by Dr Weller from his locality 6 A in the Oriskany [*op. cit.* p. 97] near Montague postoffice not far from the New York State line, is of small size with depressed dorsal valve and highly arched pedicle valve. The ribs are sparse and of those on the pedicle valve the two bounding the rather narrow median sinus are specially prominent and with them the lateral ribs are strongly contrasted in size. The lateral ribs may be, on each side of the sinus, two with trace of a third, or three with trace of a fourth; these ribs are erect, the furrows broad and sharply defined. Occasionally there is a strong rib in the bottom of the sinus, especially in the specimens from Percé. On the dorsal valve the median fold is very much depressed and may even be grooved medially and the three or four lateral plications are likewise broad and rather flat, contrasting somewhat to those of the opposite valve. The exterior of this valve is strikingly like that of some Cyrtinas. Interiorly neither valve bears septa and the usual cardinal processes are normally developed for the genus. The surface of ribs and furrows bears extremely fine concentric lines which are not fimbriate.

On the ventral valve the cardinal area is relatively high and sharply defined while on the other this area is extremely narrow. In dimensions these shells seldom exceed a width on the hinge of 20 mm and a length of 12 mm.

Localities. Everywhere along the coast at Grande Grève, Lehuquet's and Indian Cove and one of the most abundant of all fossils in Percé Rock.

Observations. The subgeneric term Metaplasia was introduced by Hall & Clarke for spirifers with smooth lateral slopes, fold and sinus on ventral and dorsal valves respectively and was applied to Hall's Spirifer pyxidatus from the Oriskany of Cumberland, New Jersey, New York and the Decewville beds of Ontario. There would be an obscuration of the original purpose of this name in applying it to a species like S. plicata.

Spirifer modestus Hall var. **nitidulus** nov.

Plate 31, figures 18–24

In the Helderbergian beds of Cumberland, Md. is a small Spirifer described as S. modestus which expresses in its outward form and characters the usual features of the Middle Devonic genus Ambocoelia save for the greater convexity of the dorsal valve. Ambocoelia unquestionably belongs in this category but has certain differentials in the arrangement of the dorsal adductor scars and cardinal structure. In the Grand Grève limestone we frequently find a diminutive shell, much smaller than Sp. modestus which carries similar characters. Its ventral valve is high and arched at the umbo, its lateral slopes abrupt, the cardinal area high and gently arched, with its sides but indistinctly defined and rounding out into the cardinal slopes of the valve, and the surface with a low median sinus but without other markings.

The dorsal valve is depressed convex, more elevated than in Ambocoelia, less so than in Sp. modestus. On the interior the narrow delthyrium of the ventral valve is bounded by thin dental lamellae which do not reach the bottom of the valve; the dorsal valve has an extremely narrow hinge area and prominent oblique crural bases. The muscle scars are not discernible on either.

Dimensions. The shells seldom attain a dimension greater than a length and a width of 5 mm.

Spirifer modestus Hall was first described in the 10th Annual Report of the New York State Cabinet of Natural History, 1857, page 61, and subsequently redescribed with illustration in *Palaeontology of New York*, 1859, volume 3, page 203, pl. 28, fig. 1a–f.

The variety nitidulus is also present at Glenerie, N. Y., where the approach to Ambocoelia in the flatness of the dorsal valve is often more pronounced. On comparison of shells from the two localities it appears

that the convexity of this valve is largely a condition of immaturity and the Ambocoelia aspect becomes hightened with increase of age. Neither of these shells gives evidence of fimbriation.

Locality. Shore outcrops at Grande Grève.

Spirifer sp. ?

Plate 32, figures 24, 25

We find two dorsal valves characterized by their low median fold, depressed lateral slopes and smooth nonplicate surface. One of these apparently had a fine lineate surface ornament. The valves pertain either to a Spirifer or Cyrtina of unusual type.

Localities. Grande Grève and Indian Cove.

Cyrtina rostrata Hall

Plate 31, figures 25-28

Cyrtia rostrata Hall. Palaeontology of New York. 1859. 3: 429, pl. 96, fig. 1-6; pl. 98, fig. 8

Cyrtina affinis Billings. Palaeozoic Fossils. 1874. v. 1, pt 2, p. 49, pl. 3A. fig. 6, a, b

Cyrtina rostrata Hall & Clarke. Palaeontology of New York. 1894. v. 8, pt 2, pl. 25, fig. 1-8; pl. 28, fig. 6

Cyrtina varia Clarke. N. Y. State Mus. Mem. 3. 1900. p. 49, pl. 6, fig. 15-22

In species as variable as those of Cyrtina there is little to distinguish the representatives of the genus which have been described from the Oriskany fauna. Hall's figures of C. rostrata were somewhat based on old and thickened shells and this fact led Clarke to introduce the term C. varia for shells from Becraft mountain which presented some variation in size and incurvature and lacked the aspect of typical examples of C. rostrata. This same expression is maintained by the shells abundant in the Glenerie Oriskany, and between the usual habit of the latter, which are as a rule larger than those obtained in Columbia county, and that of C. affinis there is no distinction in form, plication or mode of variation. As to the identity of these forms with Hall's C. rostrata, which was described from the Oriskany of both Albany county and Cumberland, Md. and has been identified by Schuchert in the beds at Cayuga, Ontario, there is no reason for doubt.

Localities. Among the less common forms in the upper limestones at Grande Grève; also at Percé.

Leptaena rhomboidalis (Wilckens)

Plate 34, figures 1-3

For synonymy *see* Palaeontology of New York, 1892, v. 8, pt 1, p. 276.

Specimens of this ubiquitous and long lived shell are not specially common in this formation, the individuals usually being of the habit

characterizing those of the Becraft mountain Oriskany and the Onondaga limestone; rather broad rugose pallial surface with abrupt anterior deflection. Young specimens without the deflection of late growth present some resemblance to shells of Leptostrophia oriskania but both rugae and radii are stronger.

Localities. At various outcrops along the shore at Fruing's and Lehuquet's on the Forillon and also at Percé Rock.

Stropheodonta magniventer Hall

Plate 34, figures 22, 23

Strophodonta magniventra Hall. N. Y. State Cab. Nat. Hist. 10th An. Rep't. 1857. p. 54

Strophodonta magniventra Hall. Palaeontology of New York. 1859. 3:411, pl. 92, fig. 2a–c, 3; pl. 95, fig. 9

Strophomena magniventra Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 22, pl. 2, fig. 2, a

Although Mr Billings described this species in detail apparently from a free representation of it, our collections contain but a few ventral valves which may be referred to it. These bear the very broad cardinal area, the extended, fan-shaped muscular area and sparsely pustulose pallial region. It is to be remarked that the figures given by Billings of Gaspé specimens (one of his text figures is from the "Oriskany") do not express in respect to cardinal and muscle areas the full extreme of typical examples. In this regard the specimens before us are more satisfactory.

Localities. Bartlett's, Grande Grève; Billings's locality was Indian Cove; also at Percé Rock.

Stropheodonta lincklaeni Hall

Plate 34, figures 15–18

Strophodonta lincklaeni Hall. N. Y. State Cab. Nat. Hist. 10th An. Rep't. 1857. p. 55

Strophodonta lincklaeni Hall. Palaeontology of New York. 1859. 3:415, pl. 93, fig. 2, 3a–b

Strophedonta lincklaeni Clarke. N. Y. State Mus. Mem. 3. 1900. p. 53, pl. 7, fig. 37

Professor Hall described this species from brachial valves only, characterized by a quite regularly concave, almost smooth surface with fine radiating striae and concentric lines, and frequently with squamous concentric growth varices. When the writer identified and figured the species from the Becraft mountain Oriskany no ventral valves were found, and in furtherance of this peculiar fact we have before us now from the Grande Grève limestone six excellent specimens of the brachial valve and no pedicle valve which we should venture to refer to the same. This fact may lead us to

suspect that pedicle valves of the species have been brought together under some other name. We may however here note the following circumstances: With one exception all these specimens are from a single locality, the King's road at Bartlett's, Grande Grève, in the middle beds of the series. The only strophedontid associated with them here are ventral valves having the characters of S. magniventer and to which Mr Billings applied this name. It is to be noted that when Professor Hall described this latter species he was not certain that the dorsal valves ascribed to it certainly appertained thereto. We have however no such evidence as would justify us in assuming the specific identity of these valves.

Our specimens of S. linckiaeni all bear the characteristic smooth exterior marked by broad concentric festoons with finer lines grouped between them. In the Grande Grève specimens fine and very faint radial lines are visible specially in the umbonal region. These are of subequal size at the start, but at the margins of the shell they may be seen to be arranged in fascicles. On the interior of the dorsal valve the radial striation is much more pronounced and the radii are strongly pustulose. Specimens from Percé have those features quite pronounced.

Dimensions. An average specimen measures 55 mm on the hinge and 40 mm in length; thus according with the specimens of the New York Oriskany.

Localities. In the upper horizon of no. 8, Grande Grève and on Lehuquet's beach; also at Percé Rock.

Stropheodonta hunti nov.

Plate 34, figures 4-12

Shell small, regularly convexo-concave. Ventral valve most convex along the median line, where the curvature is evenly arched and well elevated; lateral slopes depressed, at times slightly concave. Hinge line long, straight, often with cardinal extensions; the length of hinge is to the length of shell as 3 to 2. The surface of the valve is uniformly smooth, usually appearing nacreous and without lineation but well preserved exteriors show an extremely fine radial striation hardly visible to the naked eye. About the umbo are a few low corrugations, three or four in number and these become extinct over the body of the valve. The dorsal valve shows the same degree of corrugation as the ventral and cardinal area of conjoined valves indicates nearly complete closure of the delthyrium and a fine denticulation extending almost to the cardinal angles. The species has been observed frequently.

The shell suggests both in size and in the aspect of its nacreous surface the well known S. nacrea[1] from the Hamilton of New York for which

[1] According to Schuchert this is the same shell as that described by Owen as Chonetes? iowensis from the Middle Devonic of Iowa and if the latter is the older species name it should take precedence.

Hall and Clarke introduced the subgeneric term Pholidostrophia.[1] Other representatives of this group are known, namely an undescribed shell from the Onondaga limestone of New York and Ohio probably the Stropho-mena lepis Bronn of the Eifel Middle Devonic. The Gaspé shell doubtless belongs in this association but we cannot, with the evidence before us, restrict the term Pholidostrophia to shells in which the surface is wholly without radial lines.

An average specimen of S. hunti measures along the hinge, 11 mm in length 6.5.

Localities. Along the shore at Fruing's and Lehuquet's, Grande Grève.

Specific name. T. Sterry Hunt, for years the distinguished chemist and mineralogist of the Geological Survey of Canada; author of a report on the petroleum of Gaspé.

Stropheodonta patersoni Hall protype **precedens** nov.

Plate 35, figures 3–13

See S. patersoni Hall and S. inequiradiata Hall. Palaeontology of New York. 1867. 4: 87, 90

Professor Hall noted in his description of the two species cited above, both from the Schoharie grit and Onondaga limestone, that while in normal forms distinction is readily made, many shades of transition in style of surface sculpture are found. The shells are both regularly convexo-concave species with denticulate hinge and with the surface ornament fundamentally consisting of fine elevated and fasciculate striae each pair of larger ones including 6 to 10 finer, multiplication of the larger consisting in the superior development of the median stria in the fascicle. These lines are finely reticulated by concentric elevated striae. Superinduced on this ornament are, as a species character, in S. patersoni, concentric discontinuous corrugations affecting chiefly the intervals between the primary striae. These occur faintly and sporadically in S. inequiradiata. Billings figures [Paleoz. Foss. pl. 2, fig. 3] from Division 1 of the Gaspé series, between Cape Rosier and Grande Grève a specimen identified as Stroph. varistriata Conrad in which such corrugated exterior is present, and we have already commented on this structure. He also insists that there is no distinction between this shell (and species) and Stroph. inequiradiata except that the former is of smaller size. Comparison of typical material representing these species however demonstrates that notwithstanding the common possession of the corrugations, Stroph. varistriata is not only smaller but more squarish in outline with nearly rectangular cardinal angles (S. rectilateralis being one of Conrad's synonyms),

[1] Palaeontology of New York. 1892. v. 8, pt 1, p. 287.

while in the other species the outline is more elongate-semielliptical, the lateral and anterior margins form a continuous easy curvature and the cardinal angles are more acutely rounded. These differences produce a notable distinction in the general habit of the species. The Grande Grève limestone shells palpably express the characters of S. inequiradiata and S. patersoni; but in so far as differences in these two are concerned it is to be noted that in the former the fasciculation is best expressed over the middle parts of the shells, but in later growth about the periphery this fasciculation gradually becomes lost or passes into an irregularly unequal striation. The corrugations are restricted to the fasciculate area.

Stropheodonta patersoni, holding its fasciculate character throughout growth, is in an arrested condition with reference to this species. The Grande Grève shells seem rarely to pass the stage in which the fasciculation of the striae is obscured as in S. inequiradiata but neither do they always present the corrugations of S. patersoni. These corrugations are usually present, sometimes very strongly developed, again obscure, but they may be altogether absent leaving the simply fasciculate exterior so prevalent in the Strophomenidae throughout their history. In view of these facts we prefer to designate the Grande Grève shells as a variation or protype of S. patersoni.

Dimensions. Fully developed examples attain a length of 25 mm and a width on the hinge of 40 mm.

Localities. Grande Grève, Indian Cove, Little Gaspé; near the top of the limestone.

Stropheodonta crebristriata Conrad (Hall) protype **simplex** nov.

Plate 35, figure 14

See Hall. Palaeontology of New York. 1867. 4:86, pl. 11, fig. 12, 13, 18–21

On comparing with the hypotypes of this species illustrated in the work cited, a few shells from Grande Grève, we observe that the young condition of S. crebristriata (a Schoharie grit species in New York) represented by the original of plate 11, figure 13 [*op. cit.*] corresponds remarkably in size contour and surface with these. The shells in hand are quite regularly convex having the greatest width along the hinge, a semi-elliptical marginal outline and the surface bears 8 to 10 sharp angular but not elevated plications, which increase in number by implantation so that the margin bears at least four times as many plications as the beak. In S. crebristriata, as referred to, there are about the same number of plications though they are individually less prominent and their duplication begins somewhat earlier. This specimen shows a fine interlineation which we observe only at the margin of the Gaspé shell.

We construe this shell as a simple and early expression of

Str. crebristriata, probably not attaining greater size or more progressed development in surface features than expressed in our specimens.

Dimensions. Length, 13 mm; width on hinge, 16 mm.

Locality. Grande Grève; shore at Fruing's.

Stropheodonta parva Hall protype **avita** nov.

Plate 34, figures 19–21

See Hall. Palaeontology of New York. 1859. 4: 85, pl. 11, fig. 5, 11

Several brachial valves show at first the median groove and four to five simple strong ribs on each side, such as characterize S. galatea, and change this expression by the simple bifurcation of these ribs at about one half their length and close upon the margin, by the subdivision of one or the other of these branches. This is the character of Stroph. parva Hall of the Schoharie grit of New York, a rare species, and comparison of the Gaspé shell with the single exterior of the brachial valve figured or known [*op. cit.*, pl. 11, fig. 5] shows similarity of dimensions to be accompanied with the like character of surface. In S. parva the ribs are not so strong and bifurcation begins sooner, that is, the period of simplicity continues longer in the Gaspé shell and hence gives it more primitive expression, in accordance with its antecedent date. These relations are shown by the comparison of the two figures here given.

Locality. Indian Cove, Gaspé.

Stropheodonta galatea (Billings)

Plate 35, figures 15–26

Strophomena galatea Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 20, fig. 9

Original description. Shell of a medium size, semielliptical; cardinal angles about 90°; sides in the posterior half nearly straight and parallel; all of the exterior half uniformly rounded. Ventral valve exceedingly convex; the cardinal angles compressed and slightly recurved; umbo very prominent, narrowly rounded, projecting beyond the hinge line; beak small, incurved; area moderately developed, strongly concave, especially under the beak and for a short distance on each side thereof. Deltidium flat, triangular, smooth; its width at the base about equal to the hight. When the surface of the area is perfect the dental striae are only indistinctly or not at all visible, but where worn or exfoliated they come out to view. They are slightly oblique, the convergence being from the dorsal edge of the area inwards, or inclining towards the beak. The area in the lower, or dorsal, one third, lies nearly in the plane of the lateral margin, but in the upper two thirds it is strongly incurved, so as to become more nearly at a right angle to that plane.

Dorsal valve deeply concave; nearly in contact with the ventral valve at the cardinal angles, and for a space of about one fourth the width, all round the sides and front; the distance between the two valves being the greatest a little above the middle. Area of the dorsal valve nearly as large as that of the ventral, parallel-sided, apparently not flat but slightly convex. It seems to form an obtuse angle with the area of the ventral valve.

Surface in one of the specimens covered with minute radiating striae, about 20 in the width of one line. Along with these there are others about twice or thrice their

size, and distant from each other from one fourth to one half a line. No large striae or ribs on the umbo. A second specimen has five or six large ribs, commencing at the beak and dying out before reaching the most prominent point of the umbo. The remainder of the surface covered with minute striae, and larger lines, somewhat like those of the last specimen, but with concave, instead of flat spaces between them.

The striking character of this species, shown well in Billings's figure but insufficiently emphasized in the description, is the bunching of coarse ribs at the beak and umbo. To start with, the shell presents a single broad median rib with three or four of lesser size on each side. These are at first separated by narrow furrows, but with growth the ribs broaden and become less distinct and the furrows likewise widen. With the completion of maturity these strong and few ribs may have become obsolete over the marginal portion of the shell, but in some specimens they are retained in force to a much later growth stage than in others. Superimposed on these ribs and becoming more conspicuous with the obsolescence of the former are fine elevated radial lines with a group of four to six smaller lines between each pair of the primary series. On the dorsal valve is a median furrow with four ribs on each side and the same superimposed ornaments.

On the interior of the ventral valve the cardinal denticulations are developed on only about two thirds the length of the hinge line from the deltidium. The muscle scars are separated by a strong and short septum.

The interior of the dorsal valve shows a low bifurcate cardinal process, hinge with fine denticulations not extending to the extremities; the muscular area is small but well defined, concentrated posteriorly, with a prominent short septum and lateral septa dividing obliquely the anterior and posterior muscle scars.

Mr Billings called attention to the relations of this shell to Stropheodonta demissa, which in early stages has strong riblets or bunches of striae in the umbonal region. Another species in which this character is better expressed and longer retained and to which we find an approximating shell in the Grande Grève limestone, is Stroph. parva Hall, from the Schoharie grit of New York. Further reference to the character of this species is made above.

Dimensions. The specimen on which Billings based his figure and measurements was much larger than any we have observed. To this he ascribes a length of 14 and a width of 13 lines. Our average specimens have a length of 14 mm and a hinge line 16 mm in length. The largest we have observed has a length of 18 mm and a width of 22 mm.

Localities. The original specimens were from Indian Cove, in limestone no. 8. Our examples are from the same locality and thence westward along the coast exposures to Fruing's.

From the typical aspect of these shells we observe departures in two directions, the first and simpler due to breaking up of the original sparse

plications near the middle of the valve, the second a quite distinct result produced by the inception of more numerous equal plications at the beak. The former is essentially equivalent to the S. parva (Schoharie grit, N. Y.) but has not attained quite such an extreme of subdivision.

Brachyprion majus Clarke

Plate 36, figures 1-6

Strophomena inequiradiata Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 24 (not fig. 13), pl. 2, fig. 4

Brachyprion majus Clarke. N. Y. State Mus. Mem. 3. 1900. p. 54, pl. 8, fig. 8-13

The typical Stropheodonta inequiradiata Hall may or may not be free of trace of corrugations but its surface striation early loses its fasciculate character, the striae becoming irregular and subequal. In distinction from this character Brachyprion majus of the Becraft mountain Oriskany, a shell of similar proportions, maintains the fasciculation of its striae throughout growth, though on internal casts this striation is obscured and so far as observed it has never manifested any trace of corrugations.

Such shells highly convex at maturity occur in the Grande Grève limestone and have been identified by Billings with Stroph. inequiradiata. They are in all essential particulars identical with shells of Brachy. majus, rather large ventral valves, convex specially in late growth and with the cardinal row of denticulations extending about half the length of the hinge. In respect to muscle scars there is also agreement in both, the area in the both valves being relatively small and flabelliform. In the dorsal valve the denticulations are shown to extend but little more than halfway from the low bifurcate cardinal process to the hinge angles.

Localities. At Grande Grève and Indian Cove.

Leptostrophia magnifica Hall

Plate 38, figures 1-2; plate 39, figures 9, 10

Strophodonta magnifica Hall. New York State Cab. Nat. Hist. 10th An. Rep't. 1857. p. 54

Strophodonta magnifica Hall. Palaeontology of New York. 1859. 3:414, pl. 93, fig. 4; pl. 94, fig. 2a-d; pl. 59, fig. 8

Leptostrophia magnifica Clarke. New York State Mus. Mem. 3. 1900. p. 53, pl. 7, fig. 36

This large and fine perplane stropheodontid occurs in such form in the Grande Grève limestones as to complete in some measure our knowledge of its surface characters. Heretofore accounts and illustrations of it have been chiefly based on casts but in these limestones where the species is

quite abundant, the shell substance is quite generally retained. Early phases of growth are also freely present.

Of its surface characters we may note that the striae are at all stages fine and round, gradually attaining unequal size by rapid implantation of later striae. Measured along the median line of an average ventral valve these striae number as follows: in a width of 5 mm at 10 mm from the beak, 15; at 20 mm, 18; at 30 mm, 10; at 40 mm, 11; showing a period of rapid increase at medium growth.

All these fine striae are crossed by minute concentric lines. The cardinal angles in full grown individuals are slightly extended and their cardinal slopes are distinctly crenulated obliquely, the wrinkles converging downward toward the axial line. These however seldom appear in young stages of growth and in some arrested cases may be absent at full size. Over the pallial region in old shells the surface becomes undulated and broadly plicated.

Of interior characters we may note the relative length of the muscle scars which sometimes extend seven tenths the length of the shell, and over the pallial region the arrangement of a myriad of fine pustules in radial inosculating rows. The hinge line is denticulate to its extremities, the denticulations extending below the hinge margin.

Dimensions. An average specimen has a length of 50 mm and a diameter on the hinge of 70 mm. The largest shell observed is 75 mm in length.

Localities. Abundant at certain localities in association with Chonetes canadensis, near the base of no. 8, Dolbel's brook; Shiphead, 300 feet below lighthouse; also found loose at Peninsula. So far as observed not associated with L. irene. The species occurs abundantly in the sandy Oriskany shore deposits of central and western New York, but rarely in the calcareous deposits at Becraft mountain. It is also found in the same formation at Cayuga (Schuchert) and Haldimand (Billings), Ontario, and at Cumberland, Md.

Leptostrophia magnifica var. tullia (Billings)

Plate 37, figures 1-6

Strophomena tullia Billings. Palaeozoic Fossils. v. 2, pt 1, 1874, p. 29, pl. 2, p. 6, 6a

Original description. Shell large, nearly flat, semielliptical, cardinal angles sometimes slightly extended; sides in the posterior half straight or gently concave; anterior half broadly rounded; width on the hinge line from one sixth to one fifth greater than the length.

Ventral valve very slightly convex, most elevated in the middle or a little above, compressed towards the cardinal angles. Area about two lines high at the beak, inclining backwards at an angle of about 45° to the plane of the lateral margin.

In the interior of the ventral valve the muscular space is subtriangular, rounded in

front, with straight or gently concave sides, and extends about half the length of the shell. The width of this space, in a specimen thirty lines wide on the hinge line, is thirteen lines across the anterior angles. Its length the same. In a smaller specimen, sixteen lines wide on the hinge line, the length of the space is about seven lines, its width at the front five lines. The divaricators are divided into a number of longitudinal lobes, seven or eight in large individuals, fewer in the smaller, and sometimes very indistinct. The occlusors are narrow and half the length of the other two, very indistinct. The mesial septum sometimes extends the whole length of the muscular impressions, and becomes stronger on approaching the beak; in the small specimens it is very slight or absent altogether.

Surface with fine, rounded radiating striae, ten or twelve in the width of two lines. These are crossed by very fine concentric striae, which disappear when the shell is slightly worn or exfoliated. In the cast of the inner surface of the ventral valve, all the space between the muscular impression and the cardinal angles is punctured. All around the sides and front margin the punctures are very small, and partially arranged in rows conforming to the radiating striae.

The specimens as yet collected are not in a condition to show the area perfectly. It is, however, vertically striated and denticulated throughout nearly, if not entirely, the whole length. There seems to be a small triangular deltidium with a cavity beneath it.

Width of the largest specimen collected forty-two lines; length of the same three inches; dorsal valve unknown.

In S. blainvillei the divaricators extend nearly two thirds the length of the shell; in this species about half the length. It approaches S. magnifica in size, but the form and proportional length of the muscular impressions are different in the two species. It is closely related to S. beckii Hall, but attains a much larger size; is not concentrically wrinkled; has finer radiating striae and a deltidium. S. irene has only four or five radii in the width of two lines while this species has ten or twelve.

Locality and formation. Mount Joli and Split Rock, Percé. Lower Devonian.

This is the prevalent Leptostrophia at Percé and may be regarded as the local variant of L. magnifica as the points of difference though at once recognizable are relatively few. These are chiefly the absence of oblique crenulations near the hinge angles and a difference in the character of the striae; we need put little emphasis on variations in muscle scars for these in large examples are hardly to be distinguished from those of L. magnifica. Billings, however, apparently included two distinct forms under his term S. tullia and in the rarer of these which we describe below there is a prevailing uniformity of surface striation which is in contrast to that of the species under discussion. The latter has not the regular thread lines as described by Billings, but highly irregular lines almost alternating in size or tending to fasciculation with a group of lesser ones between a pair of stronger. These differences are brought out in our illustrations. The prevailing size is rather small; large shells are infrequent.

Locality. Very abundant at Percé Rock, frequently covering entire slabs.

Leptostrophia irene (Billings)

Plate 38, figure 3; plate 39, figures 5-8

Strophomena irene Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 27, pl. 2, fig. 5, 5a

Original description. Shell large, nearly flat; cardinal angles usually slightly projecting; sides in the posterior half either straight and subparallel or gently concave and converging towards the front; anterior half broadly rounded; front margin sometimes nearly straight in the middle. Width on the hinge line usually from two to three inches; length from one sixth to one third less than the width.

The ventral valve is very slightly and uniformly convex, most elevated about the middle or a little above, compressed towards the cardinal edges; umbo and beak small; area about two lines high at the beak in a specimen 2½ inches wide inclining backwards at an angle of about 45° to the plane of the lateral margin. Dorsal valve gently concave, conforming in its curvature to that of the ventral valve; area half a line wide, forming nearly a right angle with the ventral area. The muscular impressions of the ventral valve are rather large, flabellate, extending from the beak nearly half the length of the shell. The divaricators (in the only specimens in which they have been seen) are divided into six or seven longitudinal lobes, not distinctly defined at their anterior margins. The occlusors occupy an elongate, narrow space, and seem to extend from near the beak to near the front of the divaricators. There is a slightly elevated mesial septum between the occlusors, one half or two thirds their length from the beak. Hinge line crenulated, apparently nearly out to the end. Deltidium and internal characters of the dorsal valve unknown.

Surface with coarse, flexuous, slightly elevated, rounded, radiating striae, which increase, both by bifurcation and intercalation, four or five in the width of two lines. When the surface of the shell is perfect, it exhibits a set of fine but very distinct concentric striae, six or seven in the width of one line. When partially exfoliated these become obscure, or disappear altogether. The shell is not punctate.

The differences in L. irene and L. magnifica are readily apprehended. The coarse striae of the former are specially noteworthy and for comparison we note their number as follows: in a width of 5 mm at 10 mm from the beak, 8; at 20 mm, 5; 30 mm, 5; 40 mm, 5; 50 mm, 6. This statement may be compared with that given for L. magnifica. Further, the interstrial grooves are broad, the concentric lines very obscure, the oblique cardinal crenulations generally absent, faint if present. Of the interior characters Billings has shown that the muscle scar of the ventral valve is shorter or less expanded than in L. magnifica and we observe that the pallial region is much more sparsely pustulose and the cardinal denticulations are smaller. The dorsal valve was not described by the author cited. We find it in a small specimen to be almost if not quite flat but the interior has not been observed.

Dimensions. Length of largest specimen, 64 mm; width on hinge, 75 mm. Other specimens measure 58 and 46 mm in length, 68 and 62 mm along the hinge.

Localities. This species is less common in the limestone fauna than L. magnifica and has not yet been found in association with it. Our

specimens are from Indian Cove and along the shore outcrops above and below Fruing's, considerably above the horizon of L. magnifica. Billings's specimens were also from Grande Grève.

Observations. The genetic relations of this species to L. magnifica seem to be the following: In its various structural details, coarser plication, smaller muscle scars, usual absence of cardinal crenulations, smaller cardinal denticulations and less pustulose interior all harmonize to indicate a more primitive expression, or a form which when departing from the specific type has maintained its primitive expression. Leptostrophia magnifica has traveled far from this prolific center of dispersion but of L. irene we know nothing except in this region.

Leptostrophia oriskania Clarke

Plate 36, figures 7–18

Leptostrophia oriskania Clarke. N. Y. State Mus. Mem. 3. 1900. p. 53, pl. 7, fig. 29–35

Cf. Strophomena perplana Logan. Geology of Canada. 1863. p. 393; and S. perplana Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 32

One of the most abundant brachiopods in the calcareous Oriskany of Becraft mountain is a small perplane species with corrugated surface whose general aspect suggests close affiliation with Lept. becki Hall of the Helderberg limestone. The characters of this shell were thus defined by the writer as cited:

Shell of medium size, very gently concavo-convex. Hinge line straight, attaining the greatest width of the shell; at full growth very slightly produced at the cardinal extremities, but in young stages with quite decided extensions. Cardinal area narrow and mainly confined to the pedicle valve; striated horizontally and crossed vertically by ridges which make themselves apparent on the hinge line as denticulations. The area is crossed by a narrow delthyrium which is generally covered. Surface of the pedicle valve covered with fine, rounded striae which increase rapidly by intercalation. At intervals on the surface, usually distant, are sharply defined concentric varices or growth lines. Accompanying these are concentric corrugations, sometimes so pronounced and regular that the surface suggests that of Leptaena rhomboidalis, but generally finer and irregular. These may extend over the entire surface or be best developed in the umbonal and median parts of the shell; or they may be very obscure and often, when the concentric varices are frequent and strong, may be altogether indistinct. Along the hinge line the wrinkles are oblique, being parallel to the extended extremities of early growth stages.

On the brachial valve the ornament is of quite the same character. The apophyses and scars of the interior are those prevailing in this genus. The cardinal process is bifurcated, and the posterior face of each division is concave. From the base of this process diverge short, lateral ridges which are highly pustulose, between them lying a shorter median ridge. In both valves the muscular scars are indistinct.

Dimensions. Full grown shells seldom exceed a length of 20 mm and a width of 25 mm.

Shells with the above characters are quite freely distributed through the upper layers of the Grande Grève limestones. There is no particular

in which these seem to pass the definition of L. oriskania save perhaps in the matter of size in which they at times surpass the New York shell, and in the tendency to thicken and obscure the rugations or render them irregular. The extreme of this tendency is represented by a single specimen here figured in which the surface has become rough and squamous. There is a manifest individual difference in the character of the concentric wrinkles; if these are developed with force and regularity at an early stage they maintain this character to near full growth but if the rugae are not regular or distinct in early growth they become obsolete early.

Dimensions. An average typically developed individual measures, width on hinge, 20 mm; length 14 mm. An old and thickened example is 27 mm long and 38 mm on the hinge.

Localities. Little Gaspé; Grande Grève, abundant along the shore outcrops at Fruing's and Lehuquet's; also at Indian Cove.

Leptostrophia tardifi nov.

Plate 39, figures 1-4

Shell of uniformly medium size, averaging about that of the L. perplana; flat or broadly convex in the umbonal region, hinge line straight and not extended, commissural margin subcircular. Surface radii numerous, composed of rounded lines with very narrow interspaces, the former increasing quite irregularly by bifurcation but keeping a subequal appearance throughout. The surface seems to have been early subject to irregular growth from injury or pathologic condition of the mantle, rapid duplication of the striae following each of these cicatrices. These striae are covered by extremely fine concentric lines. Attention is directed to the differing expressions of the surface markings on these allied species, L. tullia, L. magnifica, L. irene and L. tardifi.

Dimensions of an average specimen 35 mm in width on the hinge, length 25 mm.

Locality. Percé Rock.

Species name: Richardson Tardif esq., of Percé.

Strophonella (Amphistrophia) continens nov.

Plate 40, figures 1-11

Strophomena punctulifera Conrad, variety, Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 32

Mr Billings after describing shells from division 1 of the Gaspé series (St Alban limestone) which he identified with S. punctulifera of the Helderbergian of New York, specifies a *variety* of the species in regard to which he briefly remarks:

The specimens to which the above description relates, occur in Div. 1 of the Gaspé limestone. In the upper part of the series a variety occurs with fine threadlike radii,

between every two of which there are from three to five much finer apparently from twelve to sixteen in the width of two lines. This may constitute a distinct species, but the specimens as yet collected are not sufficiently perfect to decide that point.

Such specimens are evidently those we have now in hand. These Strophonellas are well characterized, quite distinctly different from S. punctulifera and among themselves express considerable diversity of aspect. We may note first the characteristics of the prevailing expression and then its differentials. It may here be observed that in these forms again is manifested the prolixity of expression which accompanies and indicates fecundity under favorable environment.

Shell rather strongly concavo-convex, the normal convexity of the ventral valve being continued for about one third the length of the shell. The reversal is gradual but becomes abrupt specially in final stages. The hinge line is straight and the cardinal angles very slightly extended, subangular or even rounded; cardinal area narrow, not striated vertically, denticulate but slightly and only near the delthyrium of the ventral valve. The opposite valve receives this denticulate edge in a narrow crenulated groove. The muscle scar of the ventral valve is short and broadly flabellate with somewhat thickened and elevated margins. The deltidium is usually but partially developed. In the brachial valve the cardinal process is strongly bifid, the separate parts being widely separated; dental sockets shallow.

The surface of the valves is marked in the umbonal region by 16–20 sharp angular plications, simple throughout the normal contour of the valves. These primary plications with those of the secondary series eventually constitute over the body of the shell a series of fine threadlike lines separated by flat spaces in which lie fascicles of lesser order, sometimes but a single series consisting of 6 or more lines, sometimes 3 or more subordinate series. The general expression of the surface ornament however is that of fine sharply fasciculate striation. On the interior of the valves the surface is highly pustulose throughout except on the muscle areas, the pustules being arranged in radial rows.

These are the usual characters of the adult shell. The young of the species are readily recognized as normally convex shells with sharp and strong plications and this is a condition which when maintained to maturity is expressed in such species as Stropheodonta arata of the Schoharie grit of New York.

Variant (1) equiplicata [pl. 40, fig. 12, 13]. We find a few of these forms in which the simple sharp plication of growth is not broken up into fascicles but continues sharp over the body of the shell with very sparse intercalations, so that the surface conveys the expression of subequal plication and not of fasciculation. Such forms are at once distinguished by their exterior. The initial striae are a few more in number than in the nor-

mal of the species, but the variation may be interpreted as one due to the protracted continuity of the simple plicated condition of infancy.

Variant (2) senilis [pl. 40, fig. 16]. Occasional expressions occur in which the fasciculation becomes well pronounced as a secondary condition following the sharp plication of early growth but finally is obscured or lost by rapid intercalation so that the peripheral surface carries a great number of fine subequal radii. This expression doubtless represents the extreme development of the specific characters beyond the point usually attained in the normal growth of the species.

Variant (3) equalis [pl. 40, fig. 14, 15]. Again, in certain full grown shells the primitive coarsely plicate stage is so early suppressed as to be scarcely noticeable and fasciculation is at once inaugurated and continued throughout the shell growth. This is a very early assumption of mature characters unaccompanied by evidences of senile growth in final stages.

We have indicated thus the various expressions of Stroph. continens to show again what may be termed the plasticity of the shell, its easy departure from a somewhat unstable specific type, such as we should expect to occur in a center of rapid development and dispersion. It is hardly necessary to state that these variant expressions pass into one another and are to be regarded as permanent ontogenic phases rather than as stable departures from the type.

Localities. This species is very common in outcrops along the shore at Fruing's where its varieties are also present. It also occurs at Indian Cove.

Strophonella ampla Hall

Plate 37, figure 12

Strophomena (Strophodonta) ampla Hall. N. Y. State Cab. Nat. Hist. 10th An. Rep't. 1857. p. 111

Strophodonta ampla Hall. Palaeontology of New York. 1867. 4:93, pl. 14, fig. 1a–i

Strophonella ampla Hall & Clarke. Palaeontology of New York. 1892. v. 8, pt 1, pl. 12, fig. 13–15

A single external cast of the ventral valve indicates the presence of this large species. It agrees closely with the type specimens from New York in its coarse and angular plications and in the degree of reversion. A very fine concentric striation is also present on both this and one of the type specimens though this feature is not specified in either description or illustration of the species.

The close relation of this to the preceding forms is undeniable, specially to the var. equiplicata in which the primitive condition is long continued. Were it not that a specific name had already been employed for this expression in its isolated occurrence in more southerly province it would

be entirely proper and doubtless a more correct expression of its value to include it among the extreme departures of the type of S. continens.

Locality. Strophonella ampla occurs in the Schoharie grit of Albany and Schoharie counties and throughout the outcrops of the Onondaga limestone in New York, being reported also from Ohio and Ontario. The single specimen here mentioned is from Indian Cove.

GASPESIA gen. nov.

Gaspesia aurelia (Billings)

Plate 40, figures 17–19

Orthis aurelia Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 34, pl. 3, fig. 3

The singular valves which Mr Billings described under the name cited are strophomenoidlike shells with straight hinge extending the full width of the valves, central beak, which is slightly produced beyond the hinge line, a generally semielliptical outline, and the surface marked by sharp distant and sparse radial ribs. The substance of the shell is tenuous and none of the specimens show any trace of hinge structures or muscle scars and none were noted by Billings. Billings remarked that the shell "closely resembles O. pectinella Conrad of the Trenton limestone." In the apparent suppression of hinge structures we have suspected the affiliation of this species with the nearly symmetrical and thin shelled lamellibranchs of the genera Halobia and Daonella and yet there is no positive evidence that the beaks are not axial nor of any specialized anterior part which can be construed as an auricle. They are probably to be regarded as an aberrant strophomenoid, slightly convexo-concave, but the character of the shells is so peculiar as to prevent their admission to any of the recognized brachiopod genera. The strongly ribbed surface bears from 20 to 25 narrow radial plications separated by broad flat sulci which in old shells may show traces of intercalary ribs but the primary ribs are all simple. These interspaces are crossed concentrically by wavy inosculating elevated lines like the fine lines on many crustacean carapaces. We should not venture to say that the shells are of Siluric type for the comparison made by Billings is only remote, but there is a certain similarity both in form and sculpture to the species described by Hall and Clarke as Orthis ? glypta from the Niagaran dolomites of Milwaukee [*see* Palaeontology of New York, 1894, v. 8, pt 2, p. 359, pl. 84, fig. 8, 9] which has been compared with O. loveni Lindström from the Swedish Upper Siluric. One of the specimens appears to have cardinal spines near one extremity but this appearance is probably misleading as the shell may have here suffered an injury which has distorted growth.

Locality. Grande Grève. Billings's specimens were from Indian Cove.

Orthothetes (Schuchertella) becraftensis Clarke

cf. Orth. arctostriata Hall

Plate 41, figures 1–8

Orthothetes becraftensis Clarke. N. Y. State Mus. Mem. 3. 1900. p. 51, pl. 7, fig. 15–21

The species at Becraft mountain is quite uniformly of small size, with rather coarse ribbing, the plications being simple and rounded, increasing by implantation and crossed by very fine concentric lines. Specimens of this typical expression occur in the Grande Grève limestone but here it is evident that the small size is not a universal feature and must be properly estimated as a specific character of the local and typical development of the shell. Gaspé specimens reach to larger proportions, on these the striae becoming more numerous and relatively finer with age under which condition the shell puts on the aspect of Orth. arctostriata. We therefore incline to the view that the New York O. becraftensis represents a condition in which development did not progress beyond the characters described for that species while in the fertile Gaspé basin it progressed to a more advanced stage of development.

Localities. Not uncommon in the higher beds on the Grande Grève shore, in Dolbel's brook and at Indian Cove.

Orthothetes (Schuchertella) woolworthanus Hall mut. **gaspensis** nov.

Plate 41, figures 9–14

See Strophomena woolworthana Hall. Palaeontology of New York. 1859. v. 3, p. 192, pl. 17, fig. 1, 2; and Orthothetes woolworthanus Hall & Clarke. Palaeontology of New York. 1892. v. 8, pt 1, pl. 11, fig. 25–29, 31

As is well known it is not easy to discriminate species differentials in members of the genus Orthothetes. In the forms before us we are presented with a shell which approaches in general aspect O. woolworthanus of the Helderbergian (New Scotland) shaly limestone; it has the long and straight hinge, subsemicircular rarely subelliptical outline, sometimes elongated and in the character of the surface there is comparatively little difference. We observe however that in O. woolworthanus the ventral beak is rarely greatly elevated and distorted while this distortion is present in mut. gaspensis, giving the valve at times the aspect of O. deformis Hall (New Scotland beds). The shell substance is much the thicker in the latter; the muscle scar of the ventral valve is much larger in the mutation and the pallial surface is vascular. In the dorsal valve the muscle scar of the mutation is larger, sharply subdivided and the pallial surface strongly marked with impressions of mantle vessels, the trunks of which are median, departing forward from the front end of the muscle area.

In O. woolworthanus the shell is so thin as to seldom show these scars. In both valves the plications are sharply defined about the periphery. On the exterior the mutation shows a rather regular inequality in the striae which in total are probably less in number. The differences are sufficient to indicate a modification of the earliest type expressed in O. woolworthanus.

The shell attains considerable size, fully that of large examples of O. woolworthanus.

Localities. The best and most abundant specimens are from Shiphead, 300 feet below the lighthouse, Cape Gaspé. It has also been found at the Grande Grève outcrops.

Hipparionyx proximus Vanuxem

Plate 42, figures 6–11

Hipparionyx proximus Vanuxem. Geol. N. Y. 3d Dist. 1842. p. 124, fig. 29, no. 4

Orthis hipparionyx Hall. Palaeontology of New York. 1859. 3:407, pl. 89, 90

See also Palaeontology of New York, v. 8, pt 1, p. 257, pl. 9; and N. Y. State Mus. Mem. 3, p. 52

This characteristic Oriskany species which abounds in the sandstones of central New York but is less frequent in the calcareous facies of Columbia county, occurs at Grande Grève in typical examples. These may not attain as large a size or as ponderous a shell as the species does occasionally in the sandstone of New York but in respect to structures there is no distinction. Some of these specimens replaced throughout by silica show specially well the character of the dorsal valve in which the cardinal area is preserved as short and very narrow, the dental sockets deep and curved, the cardinal process high, recurved, bifurcate, the posterior grooved faces of the branches standing in the plane of the cardinal area; the interior is margined by a sharply plicate border which extends all the way around from within the ends of the cardinal line; the muscular impression of this valve is broadly flabellate, not distinctly divided transversely but separated medially by a low ridge. The ventral valve has the usual large muscle scars with thickened outer edge.

Specimens measure from 55 to 60 mm in length, by 65 to 70 mm in width.

Localities. Found rather commonly in association with Rhipidomella musculosa at Dolbel brook near the bottom of the section. Examples of the species are occasionally obtained at Percé Rock.

Genus **RHIPIDOMELLA** Oehlert

The species of this type in the Grande Grève limestones present a very interesting array of characters but it is not easy to interpret their standing

with reference to the known species of the more southern province because of the frequency with which a given specific group presents the differentials of more than one of the affiliated forms. This situation is somewhat further complicated by the ready passage of more extreme forms of Rhipidomella into the conservative expression of Hipparionyx proximus. The work of Billings has not given much aid in the interpretation of these relations. In the lists of fossils cited by Logan, for which Billings was responsible, Orthis oblata (a Rhipidomella described from the Helderbergian of New York) was given, but in the *Palaeozoic Fossils* the only species of this type referred to is Orthis livia which Billings had described in 1860 from the Onondaga limestone of Ontario and Hall had subsequently identified in New York [Pal. N. Y. 1865, 4:38]. Billings however gives only a reproduction of his original description and figures and makes no mention of the special traits of the Gaspé shell. After careful analysis we conclude that the more closely related shells of the Rhipidomella type here present are divisible into three groups whose differentials will be presently noted: (1) a relatively small species of the general aspect of R. oblata; (2) a larger form which is in a certain sense an intensified expression of R. musculosa and (3) a conservative expression of Hipparionyx proximus.

Rhipidomella musculosa Hall

Plate 42, figures 1–5; plate 43, figures 14, 17, 19, 20, 22

Orthis livia Billings (in part ?). *op. cit.* p. 32
Orthis musculosa Hall. Palaeontology of New York. 1859. v. 3, p. 409, pl. 91, fig. 1–3; 95, fig. 1–7
Rhipidomella musculosa Hall & Clarke. Palaeontology of New York. 1892. v. 8, pt 1, pl. 6A, fig. 5

These shells are conspicuous for their size, averaging on the whole larger than the representatives of the species from the littoral sand deposits of the Oriskany of New York.

They are strongly developed in all details, the muscular scars of the ventral valve being very large and extending well toward the anterior margin and the median ridge between the adductors is frequently elevated into a strong septum. The pallial region, though narrow, is ridged and pustulose and the shell substance in this valve frequently very thick, the scars being deeply excavated with elevated margins. The dorsal valves are quite convex and have the aspect of dorsal valves of Hipparionyx though less transverse on the hinge margin. From the beak the margins slope away in a characteristic manner. The elevation of the surface is greatest at about the middle and the slope therefrom gentler toward the postlateral margins than toward the front. The crural processes are well developed but the cardinal process is rather short, not projected beyond the hinge margin and its posterior face is not trifid but chevroned. The shell substance is punctate in the inner layers.

Dimensions. Ventral valves measure in width and length from 40–50 to 40–45 mm and dorsal valves about 45 mm in each dimension.

The size of these shells and their close approach to the contour and details of structure of Hipparionyx leads to easy confusion with the latter. The critical structures of the former are the very conspicuous deeply cleft cardinal process whose lateral walls are continuous with the low crural processes, and also the apparent absence of punctation in the shell.

Locality. Abundant on Dolbel brook, associated with Hipparionyx proximus; base of Logan's limestone no. 8.

Rhipidomella logani nov.

Plate 43, figures 15, 16, 18, 21

Prob. Orthis oblata Logan (Billings). Geology of Canada. 1863. p. 393
Orthis livia Billings (in part). Palaeozoic Fossils. 1874. v. 2, pt 1, p. 32

Lens-shaped, subcircular shells, subequally convex in the posterior region, the ventral valve depressed anteriorly while the dorsal maintains its convexity. The slope of the surface of the dorsal valve is even in all directions and much more abrupt than in the ventral valve, the former is hence considerably the deeper valve. Little value can be laid upon the characters of the external markings which in all these species are fine, subequal, rounded and sharply elevated lines.

In the ventral valve the cardinal area is high and rather narrow, the delthyrium broad and the teeth well defined but not conspicuously elevated. The adductor scar is broad and flabelliform, extending one half the length of the shell and inclosing narrow and elongate oval diductors. The pallial region is well marked by pallial ridges which inosculate freely. In the dorsal valve the cardinal area is narrow and not long enough to materially modify the almost circular outline of the valve. The crural processes are conspicuous and divergent and the cardinal process rather diminutive, curved forward, trifid at its end which does not project beyond the hinge.

In size, a width of 34 mm and a length of 29 mm is an average maximum and the limit of variation in size is not far from this.

Locality. In the middle limestones at Grande Grève and Indian Cove.

Rhipidomella lehuquetiana nov.

Plate 43, figures 7–13

Shell small lenticular or subplanoconvex. General outline subcircular, a little wider than long. Ventral valve depressed, beak generally obscured or resorbed, umbo depressed; a broad and low sinus begins in the umbonal region, widens outward and becomes deep on the anterior margin making a strong sinuosity or tongue extending upward into the other valve. The

surface at the sides of the sinus is broad and flat except about the margins where it is more abrupt.

Surface radii fine, rounded, numerous and subequal; cardinal area moderately high and curved downward at the sides. On the interior the delthyrium is relatively broad and has encroached upon the beak, the pedicle cavity is deep, the teeth stout and thick. The adductor scars are very long, flabellate and extend almost to the anterior margin. They are bounded at the sides by the thickened extension from the teeth but in front they are not deeply impressed. They are divided by a median septum which almost reaches the margin. The diductor scar is elongate oval and posterior.

The dorsal valve is more regularly convex though flattened medially with angular slope in all directions. It is sinused on the anterior margin. The beak is blunt and the margins slope away from it at a low angle. On the interior the socket walls are stout and high, the sockets moderately deep and the cardinal process rather feebly developed, being fused with the adjoining walls and not projected beyond the hinge line; it is not divided. The muscular scars are posterior in a single or double subcircular pair separated longitudinally by a broad low and short ridge.

Dimensions. These shells measure in full growth about 15 mm in width by 12 mm in length.

This peculiar little shell which is quite abundant bears the characters of senility as expressed in its thickened shell and shell processes and the usual resorption of the beak by the delthyrium. It has the general characters of Rhipidomella modified to the expression presented by Orthis dubia of the St Louis limestone [*see* Pal. N. Y. v. 8, pt 1, pl. 6A, fig. 18–22] which is a gerontic form with such outline.

Locality. At Lehuquet's beach, Grande Grève and eastward, near the top of the series.

Specific name. Lehuquet, a Jersey surname on the Forillon.

Orthis (Rhipidomella) nov. ?

Ventral valves of circular form, decidedly convex for the genus in the umbonal region and with a uniform slope to the margins, bear rounded and coarse radii, these slowly increasing by implantation except about the edge where the radii are sharply defined on the internal surface. The muscular area of the valve is distinctive in the shortness of the flabelliform scars which are restricted to the posterior third of the valve. The hinge line is quite short and distinctly elevated. Dorsal valve unknown. This appears to represent a very distinct species but we are not able to characterize it further as specimens are not frequent in our material.

Locality. Grande Grève, middle beds.

Schizophoria ? amii nov.

Plate 44, figures 21–25

Shell of medium size, transversely subelliptical in outline. Ventral valve with slightly prominent beak which is not depressed but from the umbonal region departs a low median sinus which widens posteriorly and covers one third the width of the valve at the anterior margin. The dorsal valve is the more convex specially in the median region which is elevated into a broad ridge corresponding to the concavity of the ventral. From this central ridge the sides slope somewhat abruptly and with a slight depression postlaterally. The surface is marked by fine angular radii very like those of Dalmanella lucia and are rapidly increased by implantation. Sometimes these striae are seen to end abruptly in elongate punctae as in some species of Rhipidomella (R. penelope Hall, Hamilton). The surface is crossed by fine and obscure concentric lines. On the interior the ventral valve bears flabellate muscle scars but it is not known whether the scars of the dorsal valve conform to those of Schizophoria. Specimens of this species are easily confounded with those of Dal. lucia but the contour of the two is exactly reversed.

Dimensions. A normal specimen measures 18 mm in length and 20 mm in width.

Locality. Rare at Grande Grève.

Specific name. H. M. Ami, eminent Canadian paleontologist.

Dalmanella lucia (Billings)

Plate 44, figures 8–20

Orthis lucia Billings, Palaeozoic Fossils. 1874. v. 1, pt 2, p. 35, pl. 3, fig. 4, 4a

The original description of this species is as follows:

Shell subcircular; outline concave on each side of the beak; cardinal angles broadly rounded; sides gently convex; front either broadly rounded or with sometimes a portion in the middle projecting. Ventral valve moderately convex, most prominent about the middle or a little above; cardinal margin and sides slightly compressed; umbo well developed, carinating the valve in the upper half; beak minute, incurved at a right angle over that of the dorsal valve, and apparently in contact with the same; area very small, scarcely visible. Dorsal valve very slightly convex; a barely perceptible mesial depression originating in a point at the beak and gradually widening to the front, where it flattens about one half the whole width of the valve. Beak minute, but distinctly visible when that of the opposite valve is removed; cardinal edge slightly sloping on each side of the beak; area not visible.

Surface with fine subangular striae which bifurcate several times; those at the cardinal angles, and for some distance below, curving upwards as they approach the margin; four or five striae in the width of one line.

Width of the largest specimens seen, eleven lines; length, about nine lines.

Closely allied to O. planoconvexa, Hall, Palaeontology of New York, volume 3, plate 12, but differs in having no area as that species has.

Locality and formation. Indian Cove, Gaspé, in limestone no. 8.

Mr Billings very properly compared the species to O. planoconvexa of the Helderbergian fauna which it resembles not alone in contour but in the character of the muscle scars on both valves. The shell is of a form unusual in the Devonic but highly characteristic of late Siluric stages.

Dimensions. Average length 21 mm, width 21 mm. This species occurs quite freely in the Oriskany of Glenerie in finely replaced specimens and imperfect specimens from Becraft mountain doubtfully referred by the writer to Dalmanella perelegans [N. Y. State Mus. Mem. 3, p. 57] are evidently of the same character. Orthis discus of the Helderbergian is a close ally but has more equally convex valves.

Locality. We have found this shell to be quite rare at localities about Grande Grève.

Chonetes canadensis Billings

Plate 45, figures 16–27

Chonetes canadenis Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 17, fig. 7

Original description. Shell semicircular or semielliptical, the proportional length and width variable. Ventral valve gently convex, in general most elevated at about one third the length of the beak; the cardinal angles flattened or slightly concave; umbo broadly depressed, convex; beak scarcely distinguishable from the cardinal edge. The area is rather large, being about a line high at the beak; nearly flat or very slightly concave, nearly smooth, no traces of crenulations; inclining backwards at an angle of about 45° with the plane of the lateral margin. The foramen is triangular, its width at the base nearly twice its hight, extending nearly to the beak.

Dorsal valve gently concave, corresponding to the ventral valve, in its curvature, so as to leave only a thin space between them. The area is about one third or one half the size of that of the ventral valve, and forms nearly a right angle with the plane of the lateral margin.

The surface is covered with very fine, obscure radiating striae, from ten to fifteen in the width of two lines. Some specimens, also, exhibit a number of concentric ridges or undulations of growth. Many show shallow, concave furrows from half a line to one line wide, which radiate from near the beak to the margin. These are most distinctly seen in specimens from which the shell is either wholly or partially removed. In such cases these furrows are either straight or slightly curved, the convex side of the curve being outwards, towards the sides. When the shell is a little worn fine closely arranged punctures may be seen between the striae. When the shell is removed, the cast of the inner surface is sometimes quite rugose with punctures and obscure irregular tubercles. Often, however, the cast only exhibits the radiating striae.

In some specimens, the cardinal edge of the ventral valve is quite sharp, and does not exhibit any indications of spines. In others there are four or five small tubercles or rudimentary spines, on the cardinal edge. When they can be seen they appear to be short, nearly erect or curving slightly inwards. The following are the dimensions of several specimens in lines, the first number in each case being the width, 6 — 3½; 16 — 10; 20 — 12; 22 — 12; 24 — 14.

Small specimens of this species have nearly the proportion of Ch. melonica but are always nearly flat, while those of the latter are always more convex.

To this diagnosis of this large and fine species should be added (*a*) the more conspicuous development, specially in early stages, of the median stria on the ventral valve, less frequently such a stria or even median sinus on the dorsal valve, (*b*) the prominence of the dental sockets running nearly parallel to the hinge and extending two thirds the distance to the cardinal angles, (*c*) the bifurcate cardinal process, each branch of which is divided in half, (*d*) the pustulose character of the interior of the dorsal valve; in early stages single rows of pustules arranged upon the internal striae present themselves but these simple lines become confused in later growth and the surface assumes low radial folds over the pallial region, (*e*) the absence of defined muscle scars on either valve.

The enlarged median stria is a dependable feature in determining the young forms of the shell with which the rocks abound; the accompanying depressed convexity, almost flatness of the valve, serving to distinguish them from Ch. antiopa.

Localities. Found in great quantity in the lower strata on Dolbel brook ¼ mile above the shore; Shiphead, Cape Gaspé, 300 feet below lighthouse. This horizon is near the base of Logan's no. 8. Elsewhere the species is rare. Billings's locality was Percé Rock, and here the species occurs in extraordinary abundance and constitutes the leading member of the entire fauna where it is also extremely common.

Observations. Embedded in the rock at Shiphead was found a small conical mass of very young shells of this species, the base of the cone upward. Some hundreds of shells seem to have been involved in this mass where was doubtless a small eddy on the bottom which produced a conical depression and in which the revolving water caught and whirled the Chonetes. The center of this cone is sediment, the shells being thrown toward the periphery.

Chonetes melonicus Billings

Plate 46, figures 1–4

Chonetes melonica Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 15, fig. 6a–d

Original description. Shell of medium size, usually about ten or twelve lines wide; length between one half and two thirds the width; hinge line equal to the greatest width of the shell; cardinal angles usually 90°, often a little less or more; all the front two thirds of the shell uniformly rounded, sometimes with the front margin only very gently convex. Ventral valve usually strongly convex and often extremely gibbous, always more or less flattened toward the cardinal angles; area rather narrow, sometimes lying in the plane of the lateral margin, but more often, owing to the strong curvature of the upper part of the valve, partially inverted; foramen a little wider than high, closed by a convex deltidium; lower edge of the area in detached valves crenulated or serrated with small teeth, of which there are six or seven in one line; these teeth not visible when both valves are united; when the shell is well preserved and semitranslucent, faint, dark lines can be seen beneath the surface of the area, as if it were penetrated by internal small tubes, passing from the teeth towards the cardinal edge, and inclining a little towards the beak; umbo moderate,

but in the most ventricose specimens, the umbonal region is so exceedingly tumid, that it projects a little over the hinge line; beak not distinct from the cardinal edge. Dorsal valve with a curvature corresponding to that of the ventral, leaving but a thin space for the animal; area half the size of that of the opposite valve, and forming an obtuse angle therewith.

There are three or four spines on the cardinal edge of the ventral valve, rarely preserved. They incline outwards at an angle between 40° and 50°. I have seen no specimen with all the spines preserved, but it seems probable that those nearest the beak are the shortest.

Surface with fine, closely arranged, convex ribs, eight to ten, on an average in the width of one line, increasing both by bifurcation and interstitial addition, and crossed by exceedingly fine concentric striae, of which there are between thirty and forty in one line. The ribs are slightly flexuous and of a very uniform size. In some specimens, the ventral valve exhibits an obscure mesial sinus extending from the beak to the front margin.

To the excellent description and illustration of this species given by its author we have little to add. The specimens which we refer thereto show some variation in outline from the usual transverse shape, occasional shells being more extended in front, with narrower and flatter cardinal slopes. While the contour is generally gibbous longitudinally with quite abrupt anterior and posterior slopes. The more elongate shells have these slopes more gradual. The surface striae in many cases vary more than is indicated by Billings and may increase suddenly and rapidly at a growth line by the implantation of numerous finer lines. Frequently on the ventral valve the median stria is larger than the rest, but relatively less so than in Ch. canadensis. The striae of the ventral valve at times become very obscure in adult growth over the pallial and lateral regions and then the surface shows the fine concentric lines otherwise scarcely visible.

The interior of the ventral valve shows pretty widely explanate fan-shaped muscular scars separated by a short but stout septum. And on the dorsal valve the reniform ridges are quite distinct. The cardinal features, which Billings specially illustrated, and the denticulation of the hinge, are clearly observable in some of our specimens though the denticles are but short and ill developed. This crenulated hinge also occurs in species of the Gaspé sandstone and is considered on a following page.

Dimensions. An average normal specimen measures 22 mm in width on the hinge, 12 mm in length. Another with the same length of hinge has a length of 14 mm.

Localities. Mr Billings cited the species only from Little Gaspé in limestone 8. We have it also from this locality and from Indian Cove, 2 miles east of Grande Grève. It seems to be peculiar to the upper beds of the series.

Chonetes antiopa Billings

Plate 45, figures 1–5; plate 46, figures 5

Chonetes antiopa Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 19 (not figured)

Original description. Shell small, semielliptical; cardinal angles about 90°; sides nearly straight in the posterior third or half of the length, anterior angles uniformly rounded; front margin broadly or gently convex; width about one fourth or one half greater than the length. Ventral valve moderately and sometimes rather strongly convex, most elevated about the mid-length; somewhat compressed at the angles; umbo usually slightly elevated. Often the shell is more or less abruptly inflected about the mid-length, with a flattened or only gently convex slope to the front margin. Sometimes there is a shallow groove, which extends from the beak along the median line to the front. There are two spines on each side of the beak, slightly sloping outwards, nearly erect, sometimes gently curved, the convex side of the curve outwards. There may be a third spine at the cardinal angle, but it has not yet been observed.

The surface to the naked eye appears nearly smooth, but, when magnified, exhibits about fifteen rounded, subangular striae in the width of one line.

Width four or five lines. Although a large number of specimens have been collected, none of them exhibit the area or the dorsal valve.

To the above description should be added the fact that the median stria of the ventral valve is usually more prominent than those adjoining while one or two others may also be conspicuous. Except in its greater convexity the species thus resembes the young of C. canadensis. The hinge line in C. antiopa is without crenulations.

While the characters of the species are well depicted in this description it is clear that they are in many respects those of Ch. hudsonicus Clarke. This agreement is seen in the outline, fine striation, shape of spines, even the low median sinus on the ventral valve of the latter being apparent in Ch. antiopa. It is however a uniformly small shell never attaining the size of Ch. hudsonicus. In describing other Chonetes of this fauna we shall observe that the species of the Grande Grève limestones and Gaspé sandstones present a series of forms which are in effect developmental expressions of a single specific type. Within this series we shall find embraced Ch. antiopa as the simplest term; the relations of this to Ch. hudsonicus are very close both in form and exterior. The next stage is Ch. hudsonicus metatype gaspensis from which Ch. melonicus is distinguished chiefly by its greater gibbosity and more elongate hinge; Ch. canadensis is in the same line of development so far as its exterior is concerned but has reverted in the character of its hinge to the nondenticulate type.

Localities. Quite abundant at Percé Rock, from which the original specimens were obtained. The specimens at Indian Cove and from the lower beds on Dolbel's brook on the Forillon are less convex than those of Percé but in other respects appear to be identical.

Chonetes billingsi nov.

Plate 41, figures 18–30

Chonetes laticosta (Hall) Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 20

Under Hall's name Ch. laticosta Mr Billings described at some length a small highly convex shell with few and strong ribs. This name was introduced by Hall in 1857 [N. Y. State Cab. Nat. Hist. 10th An. Rep't, p. 119] for a Chonetes from the Onondaga limestone, but at a later date the author withdrew the name identifying that shell with Ch. mucronatus of the Marcellus fauna [Pal. N. Y. 1867, 4:124].

These Gaspé shells which are very abundant in various stages of growth are characterized by the high gibbosity of the central region and abrupt slopes to the margins in the pedicle valve and the coarse rounded ribs separated by interspaces of about the same width. These ribs are usually simple, extending from beak to margin and number from 16 or less in small individuals to 26 in the largest shell seen. In full growth of the shell the median rib becomes more pronounced than the rest on the anterior margin and thus makes a low median angle at this margin. Extremely fine concentric lines are visible under favorable preservation. The cardinal area is narrow and only in rare instances are spines retained or developed at the cardinal extremities. On the interior the brachial valve has a small erect v-shaped cardinal process and short thin outer socket walls. On each of the simple coarse ribs which correspond to the furrows of the exterior is a single row of sharp pustules the median row being the most depressed, and the two adjoining the most prominent. No trace of reniform or other lateral depressions is evident. In all such small and coarse ribbed species represented by Ch. billingsi, Ch. laticosta and Ch. mucronatus, there is a natural similarity of expression extending even to the interior characters of the brachial valve, but the distinctive differences of Ch. billingsi consist in its gibbosity, angulated front margin at maturity, stronger, coarser and more uniformly simple ribs. In respect to these characters in all the shells they are the most pronounced in that before us and become progressively decreased in the upward range of the group, so that it serves the purposes not only of paleontologic but also of geographic distinction expressly to recognize this early manifestation of features which are less pronounced in Ch. laticosta of the Onondaga limestone and still further diminished in Ch. mucronatus of the Marcellus and Hamilton.

Dimensions. A full sized example has a width on the hinge of 13 mm and a length of 11 mm. From this the size ranges downward to a length of 2 mm.

Localities. Everywhere abundant in limestone 8 in the shore outcrops

at Grande Grève specially above Fruing's and at Lehuquet's; Cape Rosier road at Bartlett's; also at Indian Cove. Billings cites in addition, Little Gaspé.

A single example of the species has been found in the Gaspé sandstones on the Portage road near Gaspé Basin. This is a large gibbous ventral valve with sharp plications one of which shows bifurcations, an unusual condition but the shell seems to be in no essential particular unlike those of the limestones.

Chonetes sp.

A rather small Chonetes with smooth exterior has been observed in a few instances. These have a quite strongly and regularly convex pedicle valve, widest on the hinge, with conspicuous umbo, abrupt anterior slope and depressed lateral surface. The exterior is quite without indication of markings. Old shells of Ch. m e l o n i c u s show an obsolescence of the striae approaching a smooth condition and have somewhat the form of this shell, but the specimens under consideration are always small.

Dimensions. Width on hinge, 9 mm; length 6 mm.

Locality. At Fruing's, Grande Grève.

Chonostrophia complanata Hall

Plate 46, figures 6–13

C h o n e t e s c o m p l a n a t u s Hall. Palaeontology of New York. 1859. 3: 418, pl. 93, fig. 1a–d

cf. C h o n e t e s d a w s o n i Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 18, fig. 8

C h o n o s t r o p h i a c o m p l a n a t a Clarke. N. Y. State Mus. Mem. 3. 1900. p. 50, pl. 7, fig. 7–13

The specimens identified with this species are rare in our collections from the limestones, but the six representatives before us indicate that there is no dependable difference between the shells and the New York Oriskany species. In their rather small size they approach the form described by the writer from the calcareous Oriskany of Becraft mountain, Columbia co. but we are unable to find a distinction between those and the larger, more transverse shells from the sandstone on which the species was founded. The Grande Grève shells may be either transverse and relatively narrow, or somewhat elongated on the anterior margin, and some bear a slight median fold on the ventral valve with a tendency to sinuosity or irregular radial growth on both valves. In the character of the surface striae we find the chief basis for distinction from the Chonostrophia of the Gaspé sandstone (C h. d a w s o n i). In the former the regular fasciculation of the striae is palpable from early stages on, the finer lines between the larger striae increasing by implantation and in this feature the shell agrees with C h.

complanata, while in Ch. dawsoni such fasciculation is very much less pronounced in adult growth.

There is little difference in character of exterior between this species and Ch. jervisensis Schuchert from the Oriskany beds in the Nearpass quarry section near Port Jervis, N. Y., but the latter is uniformly of small size and is very abundant at this locality. Mr Schuchert, who has described this Port Jervis shell and has compared it with one of similar dimensions from the Helderbergian fauna of St Helen's Island near Montreal (Ch. montrealensis)[1] states that the critical difference in these two small species is in the fasciculation of the striae in the latter and their subequal size in the former. If we briefly analyze this distinction among known species of the genus it is found that in the earliest form, Ch. helderbergiae H. & C., of the New Scotland beds, the lineation is subequal, in the latest Ch. reversa Whitf. of the Onondaga limestone, the fasciculation is most pronounced from early stages on. Chonostrophia montrealensis, Ch. jervisensis, Ch. complanata and Ch. dawsoni are successive variant expressions of exterior. Fasciculation of surface striae is a secondary condition and the retention of the more primitive expression as in Ch. jervisensis and Ch. dawsoni indicates delay in the assumption of mature features. We shall be justified in concluding that Ch. jervisensis and Ch. dawsoni represent one style of variation, while the group consisting of Ch. montrealensis, Ch. helderbergiae and Ch. complanata are likewise different variants of the same specific type.

In State Museum memoir 3 the writer was disposed to unite Ch. complanata and Ch. dawsoni but with present evidence, while the species are very closely alike, it seems quite possible to distinguish them [*see* description of Ch. dawsoni, p. 241].

Localities. Chonostrophia complanata has been obtained from Dolbel brook and Shiphead near the base of limestone no. 8 and in the higher beds at Little Gaspé. It is not uncommon at Percé and occurs very rarely in the Gaspé sandstones.

Anoplia nucleata Hall

Plate 41, figures 15–17

Leptaena ? nucleata Hall. Palaeontology of New York. 1859. 3: 419, pl. 94, fig. 1a–d

Anoplia nucleata Hall & Clarke. Palaeontology of New York. 1892. v. 8, pt 1, pl. 15, fig. 17, 18; pl. 20, fig. 14–17

Anoplia nucleata Clarke. New York State Mus. Mem. 3. 1900. p. 51, pl. 7, fig. 14

This diminutive species, common in the Oriskany and known in the Helderbergian of New York, occurs occasionally, the specimens showing

[1] Amer. Geol., 1901. 27: 250.

the smooth exterior of the shell and the casts of the interior bearing the fillings of the spine tubes, crossing the cardinal region of the pedicle valve, none emerging on the exterior.

Localities. Along the shore outcrops of limestone 8, at and above Fruing's and Lehuquet's, Grande Grève.

Crania pulchella Hall & Clarke

Plate 47, figures 11–15

Crania pulchella Hall & Clarke. Palaeontology of New York. 1892. v. 8, pt 1, p. 180, pl. 4, fig. 3

Crania pulchella Clarke. N. Y. State Mus. Mem. 3. 1900. p. 58, pl. 8, fig. 16–18

This is a radiated Crania which was described from the Helderbergian fauna of New York but also occurs in the Oriskany of Becraft mountain and Glenerie.

Locality. The shore outcrops at Grande Grève.

Craniella (?) grandegrevensis nov.

Plate 47, figure 16

This is one of the larger Cranias with smooth, i. e. unribbed surface. All the parts of the shell observed, which are upper valves, show a flat marginal border, the characteristic small posterior and subcentral anterior scars, with apex subcentral or posterior. Contour and margin irregular so that the marginal outline is irregularly circular, though the posterior margin is always straight.

Dimensions. Length 16 mm; greatest width 20 mm.

Localities. At Fruing's, Grande Grève. A small shell of similar character also occurs in the Percé Rock.

Pholidops cf. **ovata** Hall

Plate 47, figures 10, 11

See Hall. Palaeontology of New York. 1859. 3: 490, pl. 103B, fig. 7

Hall & Clarke. Palaeontology of New York. 1892. v. 8, pt 1, pl. 41, fig. 27–29

Species of Pholidops are for the most part of such similar character that the small shells which occur in these limestones are here referred to as probably identical with Ph. ovata which is the name given to the Helderbergian species of New York. A shell like these was noticed by the writer as occurring in the Oriskany of Becraft mountain.[1]

Localities. At Grande Grève and in Percé Rock.

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[1] N. Y. State Mus. Mem. 3. 1900. p. 59, pl. 8, fig. 21, 22. Pholidops sp. ?

Pholidops terminalis Hall

Pholidops terminalis Hall. Palaeontology of New York. 1859. 3: 490, pl. 103B, fig. 8a–d

Pholidops arenaria Hall. *Idem.* 1867. 4: 413, pl. 3, fig. 24

Pholidops terminalis Clarke. N. Y. State Mus. Mem. 3. 1900. p. 59, pl. 8, fig. 23–25

This relatively large species, characterized by its circular marginal outline, and projacent apex, is rare in the Gaspé limestone, though very common in the Oriskany of eastern New York and of Maryland.

Localities. Shore outcrops at Grande Grève and at Percé Rock.

Orbiculoidea montis nov.

Plate 47, figures 21–24

Shell very large, brachial valve highly elevated, suberect, much larger on the posterior than on the anterior slope. Posterior curvature concave beneath the arched beak; in front of the beak the surface is convex, the shell being uniformly expanded in the pallial region. Marginal outline subcircular. Surface bearing fine distant elevated concentric striae which may undulate and inosculate. These are crossed by very fine radial lines which probably do not pertain to the epidermal layer.

The pedicle valve is concave exteriorly though the beak is elevated and the pedicle slit does not extend to the margin.

Dimensions. One brachial valve, virtually uncompressed, has a diameter of 57 mm and its original hight was about 35 mm. Another which has undergone compression apparently had a diameter of about 65 mm. A pedicle valve has a diameter of 45 mm.

Localities. At Grande Grève and in the Percé Rock.

Species name. The Sieur de Monts, explorer of New France, 1603.

Orbiculoidea sp. ?

Plate 47, figures 19, 20

A species of moderately large size with suborbicular outline, regularly concentric surface markings and not highly elevated brachial valve occurs occasionally and resembles a shell found in the Glenerie Oriskany and not very unlike O. jervisensis Barrett from the Port Ewen beds of Orange co., N. Y.

Locality. Shiphead, 300 feet below the lighthouse.

Lingula rectilatera Hall

Plate 47, figures 3, 5, 6

Lingula rectilatera Hall. Palaeontology of New York. 1859. 3: 156, pl. 9, fig. 6, 8

This species was described from the New Scotland (Helderbergian) fauna of eastern New York. Excellent representatives of it occur in the Percé Rock. A similar species but with sharply concentric and elevated surface striae occurs at Little Gaspé.

Lingula spathata Hall

Plate 47, figures 1, 2

Lingula spathata Hall. Palaeontology of New York. 1859. 3: 157, pl. 9, fig. 7, 9, 11

This is an elongate shell with lateral margin gradually diverging from a blunt apex and the dorsal valve bearing a median septum. It was described from the New Scotland fauna of New York. Shells of this specific type but some of these attaining larger size than the originals, occur in the Percé Rock.

Lingula elliptica nov.

Plate 47, figure 4

Shell of moderately large size, outline elongate and regularly elliptical, there being for the dorsal valve very little difference in the curvature of the umbonal and distal extremities, the latter being very slightly transverse, the former quite regularly curved. Sides direct for a very short distance only partaking of the curvature of the rest of the outline. Surface low and evenly curved, margin bordered all the way round by a narrow flattened area; exterior marked by concentric lines of the usual style. On the interior of the dorsal valve is a long and low median ridge or septum, but in the ventral valve there is no such feature. Length 19 mm, width 10 mm.

Localities. Division 1, Dolbel brook, Grande Grève. The species seems to be also present at Percé Rock.

Glossina acer nov.

Plate 47, figures 7, 8

Shell of relatively large size, subtriangular, with acute and prominent beak from which the margins diverge rapidly for more than two thirds the length of the shell, the distance across the pallial surface being four fifths the length of the shell. Anterior margin broad and nearly transverse. Surface covered by sharply elevated and distant concentric lines which are mostly continuous though somewhat undulated but these frequently inoscu-

late and become separated by narrower intervals toward the anterior margin. Length 17 mm, greatest diameter 13 mm.

This shell is like L. perlata Hall and L. spatiosa Hall of the Helderbergian as the outline of those species has been represented but in this respect conjoined with the peculiar character of its surface markings, I am unfamiliar with any other species like it.

Locality. At the base of the formation, Dolbel brook, the Forillon.

BRYOZOA

Fenestella cf. lata Hall

Fenestella (Unitrypa) lata Hall & Simpson. Palaeontology of New York. 1887. 6: 136, pl. 52, fig. 1–10

Specimens showing both faces of the frond agree excellently with the representations of this species and these specimens were thus identified by the late G. B. Simpson. Fenestella lata is described from the Onondaga limestone of Walpole, Ontario, and the Gaspé specimens are from Grande Grève. Other fenestelloids are present in the fauna but they do not lend themselves to identification.

Stictopora sp.

A delicate form of this genus with cells in 7–9 vertical rows separated by elevated lines is of quite common occurrence in the Grande Grève limestone.

Monticulipora

There are both encrusting and branching forms of this genus which may represent distinct species. These occur in the upper beds at Grande Grève.

CORALS

Mr Billings described several species of cyathophylloids from the Gaspé localities on the Forillon and at Percé and such fossils, together with Favosites are not infrequent in the limestones of Grande Grève. The material is not often well preserved but the occasional silicification will help the future student of these bodies to more exact determinations than we care to enter upon. At Percé no cyathophylloids were found in the Percé Rock beds but we have observed the species noted by Billings, in the partly submerged reef just north of the north face of Mt Joli at an horizon just below or perhaps constituting the lower part of the Percé beds.

Several of the coral species have been carefully restudied by Mr Lambe, assistant paleontologist of the Canadian survey, and of his determinations we have here availed ourselves.

Zaphrentis incondita Billings

Zaphrentis incondita Billings. Palaeozoic Fossils. v. 2, pt 1. 1874. p. 7, pl. 1, fig. 1–2
Zaphrentis incondita Lambe. Contributions to Canadian Paleontology. v. 4, pt 2. 1901. p. 123

Original description. Corallum simple, turbinate and strongly curved at the base, becoming cylindrical above; nine or more inches in length and over two inches in diameter. From the acute base upwards it expands to a thickness of about fifteen lines in a length of two inches, and to twenty-four lines in four inches; above which the body of the coral becomes more nearly cylindrical, or only very gradually increasing in diameter. Surface with numerous engirdling ridges of various sizes, the larger are from half a line to five lines in width, and are often angular on their crests. Upon these larger ridges and in the grooves between them are numerous smaller ridges or transverse striae, generally two or three in a width of one line. The longitudinal, or septal striae, are in general only obscurely seen, being obliterated by the transverse grooves; there are five or six of them in the width of three lines.

In the interior of the coral, the radiating septa reach the center in the basal portion. But, above a diameter of one inch, there is a large space in the center (as shown in fig. 1*a*) occupied by the transverse diaphragms alone, the septa not extending more than half an inch inward. There are two sets of them, the smaller projecting upward rarely to the depth of one line. There is one of the smaller between each two of the longer.

The transverse diaphragms are well developed. They are much undulated in the central portion (as shown in fig. 1*b*) and strongly curved downwards near the exterior. There appear to be ten or twelve of them in the length of one inch; but, owing to their undulations, there are sometimes places in which they are separated to the distance of two or three lines, while elsewhere they may be nearly in contact. The septal fossette has not been observed.

Varieties. Occurring along with the above is a somewhat more slender form with, in a general way, the same external characters, but with the transverse diaphragms more regular and the septa extending inward nearly to the center. (Figs. 2, 2*a*, 2*b*) One specimen has a diameter of eighteen lines and another sixteen lines.

A third specimen is only twelve lines in diameter, with the same characters as the last two.

The materials are not sufficient to enable us to decide positively whether they all belong to the same species or not. Should there be more than one species, the specific name above given ought to be retained for the larger form first above described.

Locality and formation. Indian Cove, Gaspé, in the Gaspé limestone, no. 8.

This, according to Billings, is one of the undetermined species of Zaphrentis referred to by Logan [*Geology of Canada*, p. 393] as occurring in his uppermost division (8). The species is the common cyathophylloid of the rocks and all our specimens seem to come from the upper horizons at various points along the coast of Grande Grève.

Zaphrentis corticata Billings

Zaphrentis corticata Billings. *op. cit.* p. 9, pl. 1, fig. 4
Streptelasma prolificum Billings (?) Lambe. *op. cit.* p. 115

Original description. Corallum two or three inches in hight, straight, or only slightly curved, expanding to a width of eighteen lines at the hight of two inches. Surface (in some

specimens at least) exhibiting scarcely any trace of longitudinal striae, but marked with numerous obscure engirdling wrinkles, from half a line to one line or more in width. In addition to these, there is a set of fine striae, of which there appear to be four or five in the width of one line.

A fracture on one side of the specimen figured [fig. 4] shows that the cup is about nine lines in depth. In a polished transverse section of the same specimen at one inch from the base (just opposite the no. 4) forty-four principal septa are seen. Between each two of these there is a septum of a secondary series. Some of these latter appear to be obsolete, others project about a line inwards, while a few can be traced somewhat further. On the cast of the interior of the cup of a specimen which appears to have been about one inch in length, there are two impressions of the principal septa in one line. On the surface of a small worn specimen, nine lines in length, there are five obscure septal striae in the width of two lines. The principal septa on approaching the center unite with each other laterally two or three at a time. The septa formed by these unions again unite, thus forming fascicles of from two to seven septa in each.

The specimens do not show clearly the depth of the cup, but it appears to be at least half the length of the coral. There are several species that resemble this closely in form, but I know of none with such surface characters. In species of this genus the surface is covered with longitudinal striae, but in this the whole body of the coral, except a small portion at the base, is only transversely striated. This is owing to the thickness of the epitheca.

Locality and formation. Split Rock, Percé. Lower Devonian.

This species is definitely stated to have come from the Percé Rock, but of it we have seen nothing.

Mr Lambe refers it with some doubt to Streptelasma prolificum, a species described by Billings from the Onondaga limestone and also known to occur in the Hamilton fauna.

Zaphrentis cingulosa Billings

Zaphrentis cingulosa Billings. *op cit.* p. 10, pl. 1, fig. 5
Zaphrentis cingulosa Lambe. *op. cit.* p. 124, pl. 8, fig. 5

Original description. Corallum elongate, slender, cylindrical, more or less curved, with a number of deep concave constrictions from five to ten lines in width. Surface with strong rounded or subangular septal ridges, three or four in the width of two lines. These are crossed by fine transverse striae, of which there are four or five in one line.

The specimen, a portion only of which is figured, is six inches in length and apparently tapers about two lines. When perfect it was probably ten or twelve inches in length. It is somewhat flattened by pressure, and the form of the part figured is restored. In the interior the septa are seen to reach the center and there become much twisted and confused.

Only one specimen of this has been collected, but that is quite sufficient to show that it is distinct from any described form. In its surface characters it resembles S. rugatula, but the deep constrictions and great length are sufficient to prove it distinct. It is not certain that it is a Zaphrentis.

Locality and formation. Mt Joli, near Percé. Gaspé limestone no. 8.

Specimens of this species occur, as noted above, in the gray limestone, which forms a reef between the Mt Joli massive and the Percé Rock. The peripheral girdles are actually extended fringes or lips of old calices and

the aspect of the coral in the rock is that of a Blothrophyllum. The species will probably be found to pertain to some other genus than Zaphrentis.

Phillipsastraea verneuili (M.-E. and H.) Lambe

Phillipsastraea affinis Billings. *op. cit.* p. 11
Phillipsastraea verneuili (Milne-Edwards and Haime) Lambe. *op. cit.* p. 166, pl. 14, fig. 4

Billings's description. Corallum in the form of lenticular masses or colonies, composed of corallites of from six to eight lines in diameter, closely compacted together so that the divisions between them are only obscurely distinguishable. The cups of these corallites are indicated by a number of circular pits in the upper surface of the corallum. They are nearly three lines in diameter and two lines in depth, their walls vertical, or nearly so, a small rugose elevation in the bottom. From the margin of each of the cups, about forty septal striae radiate to the division lines between the corallites. The septal ridges between the striae are angular and minutely serrated or denticulated along the sides, and apparently along the crests. The striae are also crossed by minute transverse thread-like lines, about six in the width of one line. These characters can not be seen unless in those places where the surface is perfectly preserved. In general the rays only appear as so many small ridges, somewhat rugose in aspect.

The corallites are five, six or seven sided, and the divisions between them are indicated either by small elevated rugose lines, or by the angle formed by the meeting of the septal striae. The margins of the cups are sometimes slightly elevated above the general surface, but often are even therewith. The distance between the cups is usually five or six lines, sometimes seven or eight lines.

This species is closely allied to P. verneuili (Edwards and Haime)[1] but has somewhat longer corallites, and the margins of the cup not so much elevated.

Locality and formation. Indian Cove, Gaspé, in the Gaspé limestone, no. 8.

Mr Lambe identifies without reserve the type specimen of P. affinis with P. verneuili. The species would seem to be rare in the Grande Grève formation as it has not come to our notice.

Favosites helderbergiae Hall

Favosites helderbergiae Hall. N. Y. State Mus. Nat. Hist. 26th An. Rep't, 1874. p. 111
Favosites helderbergiae Hall. Palaeontology of New York. 1887. 6:8, pl. 4, fig. 1, 2; pl. 5, fig. 1–3; pl. 6, fig. 1–8

The common favosite of the Grande Grève strata occurs in convex coralla having a diameter of 4 to 6 inches and cells of about the same size and similar structure as in F. helderbergiae of New York with which it is provisionally associated. Like that species it bears mural pores on the lateral faces of the cells and has numerous diaphragms. This is doubtless the species which Logan referred to as F. gothlandica and F. basaltiformis in the beds of his Division 8.

Favosites helderbergiae is the common favosite in the Helderberg strata of New York. Mr Lambe [*op. cit.* p. 7] inclines to the view that there is no essential difference in the structure of the coralla described

[1] Polypiers Fossiles des Terrains Paleozoiques, p. 447.

as F. helderbergiae and F. niagarensis save in external form, the former being lenticular and the latter spherical or clavate.

Localities. Shore outcrops from Grande Grève to Indian Cove.

Favosites sp.

Probably Favosites cervicornis Logan. Geology of Canada. 1863. p. 393

This is a tuberous or branching species, less common than the foregoing and the specimens thus far examined are insufficient for determination.

Locality. Grande Grève.

Pleurodictyum lenticulare Hall

var. **laurentinum** nov.

Plate 48, figure 1

Pleurodictyum lenticulare[1] is a species of the Helderbergian (New Scotland) fauna characterized by its very large and few cells, the walls of which are strongly marked by nodose and broken septa. A central cell, hexagonal in form, is bounded by six others and it often happens that the development of this species does not pass the primitive expression. The form before us has the same form and size of cells which are marked by radial nodose and denticulated septa, these being most prominent and most irregular at the base. The lenticular corallum however grows to larger size, showing three cycles of cells about that which may be taken as central. In the measurements of the cells the New York and the Gaspé forms are alike.

Locality. Grande Grève and Percé Rock.

Striatopora cf. **issa** Hall

Cf. Striatopora issa Hall. N. Y. State Mus. Nat. Hist. 26th An. Rep't. 1874. p. 114

Cf. Striatopora issa Hall. Palaeontology of New York. 1887. 6:6, pl. 3, fig. 14, 15

A few fragments show the presence of this genus and perhaps of the species suggested in the upper beds at Grande Grève.

GRAPTOLITES

Dictyonema cf. **splendens** Billings

Represented by a few fragments from Grande Grève.

Chaunograptus gracilis nov.

Plate 48, figures 3-5

A shell of Leptostrophia magnifica has affixed to it an irregularly branching black conchiolinous repent fossil which in structure

[1] *See* Michelinia lenticularis Hall. Palaeontology of New York. 6:7, pl. 3, fig. 1-3, 5.

and substance seems to be congeneric with the peculiar organism described and figured by Hall as Dendrograptus (Chaunograptus) novellus from the Waldron (Niagaran) fauna [Geol. Sur. Ind. 11th Rep't, 1881, p. 225, pl. 1, fig. 1 and 2 (before in Alb. Inst. Trans. v. 10, abstract, p. 2, 1879)]. A comparison with the two types of this species in the State Museum, shows that the Gaspé and Waldron forms are specifically different, the Gaspé form being coarser and the apparent cells larger. Since no other form of this still problematic group of supposed repent graptolites is known, the Gaspé form is apparently new.

Its characters are: Conchiolinous, delicate, frequently and irregularly branching fronds, which are closely attached to foreign bodies and consist of curved, commalike bottle-shaped cells or branch segments, which are 1.4 mm long and .3 mm wide in their distal part and bud in such a fashion from the preceding that the branches become slightly zigzag-shaped.

The systematic position of these remains is very doubtful. By their fixation they stand apart from all other graptolites and though Hall states that D. (Chaunogr.) novellus also occurs free, the attached creeping mode of existence would appear to be the natural state of this form. Since the type of Chaunograptus novellus shows this latter to consist of a continuous tube with pores, as also parts of the Gaspé form do, a reference to the ctenostomatous bryozoans might seem appropriate were it not for the substance of the test which indicates affinity with the hydroids. Mr Ulrich who has examined the specimens of these species is disposed to exclude them as possibilities among the Bryozoa and Dr Ruedemann with some reservation accepts them as graptolites.

Locality. Dolbels brook, Grande Grève.

SPONGES

Hexactinellida

Plates A, B

Both at Grande Grève and at Shiphead are layers in the upper limestones which are matted masses of sponge spicules, for the most part obviously, but in part also, obscurely of the triaxial type. These layers in both places are several inches in thickness but there is no evidence of their continuing over the interval of four miles which separates the observed outcrops. Singularly, the spicule mass at Grande Grève seems largely constituted of the long rods of the supporting skeleton and shows but few cruciform spicules while that at Shiphead carries a very considerable variety of flesh spicules including typical and slightly modified hexactins and some extreme and novel expressions thereof but very few of the long supporting rods. We have in these rock masses the residuary evidence of the breaking down of extensive plantations of silicious sponges. So far as we have observed they have left no impressions of their body form in the sediments

but their dismembered skeletons have been scattered broadcast and the extraordinary accumulation of this debris is an index of the great profusion of these interesting forms of sponge life in the seas of the time.

The spicules of the Hexactinellida have been extensively described by various authors, Thomson, Schulze, Sollas, Rauff, Hinde, the writer and others and a somewhat bewildering nomenclature has been adapted to their various expressions. We present in the following the series of these variations so far as observed, and some of these may prove of special interest to students of the morphology of these bodies.

1 A normal smooth hexactin (*oxy-* or *liohexactin*) frequently with the arms of one axis longer than the rest. Occasionally these smooth arms are somewhat irregularly curved [fig. 17, 18, 21, 23, 24].

2 *Echinhexactins* or hexactins with thorny protuberances on the arms. These are considerably varied in size and form, some being slender with the asperities low and far apart but the commoner are large stout hexactins with the spines arranged in distinct spirals about the shaft of the arms. This is a very singular structure which so far as I know has not been observed before but is a very pronounced and common type [fig. 22, 25].

3 *Hexaster*. Hexactins with branches on the rays, generally four on each but sometimes three on one or more, are found and in these the axial shaft is continued beyond the single circlet of branches. It is very similar to a spicule figured by the writer from the Lower Carbonic, Griphodictya epiphanes H. & C.[1]

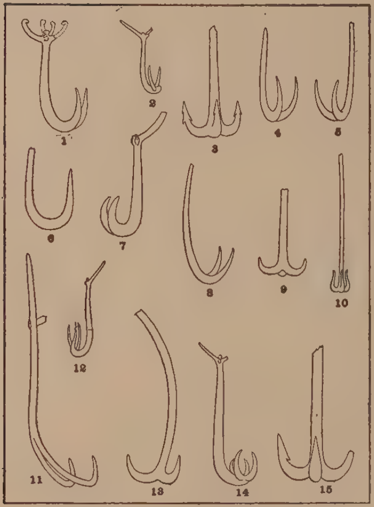
Most remarkable in this series of spicules are the ancistroid shapes presented quite abundantly in the material at hand with a variety of expressions. In several of these the triaxial origin is safely indicated though the development is essentially a single rod with terminal modifications usually at one end only. The simplest of all these hooks and one of the rarer expressions is such as is shown in figure 6 in which the shaft seems not to have been long but the recurve is deep and narrow. We have no evidence as to whether the other axes were represented in this form. The commonest of all these hooked spicules are those in which the recurved end is divided into two branches partaking of the curvature of the hook though they vary in degree of curvature and in the angle which they made with the axis. Sometimes the shaft in these is short and tapers to a point without evidence of the other axes, but usually the end opposite the grappling hook has a pronounced development of the axis shown in four curved horns spreading out and up, slightly knobbed or hooked at the ends; from within these, like the pistil of a flower, rises the short knob representing the extension of the main axis. This singular combination of hooks at one end with regular curved branches at the other is a type which evinces notable and even

[1] N. Y. State Museum Mem. 2, 1898. The Paleozoic Reticulate Sponges. p. 180.

SPONGE SPICULES

From camera drawings by the author

PLATE A



Ancistroid spicules

1 A normal and abundant form, doubly hooked at the lower axial extremity, singly knobbed at the upper, the lateral arms represented by a circlet of four up-curved and knobbed rays surrounding the upper terminus of the main axis. 2 A departure from the same structure in the form of the hook which is simple with a pair of lateral outgrowths. 3 A barbed trident. 4, 5 Two-hooked grapnels without evidence of lateral arms. 6 A "cod-hook." 7 Of the type of 1. 8 Of the type of 4 and 5. 9 A smooth trident. 10 Trident with long shaft and gracefully recurved hooks. 11 A deeply divided two-hook grapnel with long shaft bearing traces of other arms. 12 Of the type of 2 with more complete development of the primary hook. 13 An anchor with curved shaft and widely divergent hooks. 14 Of the type of 2 and 12 but with four accessory hooks superposed on the primary hook. 15 A barbed trident as 3.

HEXACTINELLIDS

extreme variation. Thus in figure 14 we have a four pronged grapnel surmounting the hook with the other end of the rod bearing the combination just mentioned. There are also double hooks, on the neck of which accessory branches are developed not as prongs but as arms at different distances from the axial apex. These are shown in figures 2, 12, wherein the branched upper end of the spicule is preserved. The tendency to add accessory branches to the neck and shaft seems to result in such comblike forms suggestive of conodont teeth as are presented in figures 16, 19, wherein there is a loss of the symmetrical development shown in the simpler spicules.

In figure 11 is represented a slender and very deeply divided two pronged grapnel, with a rather different type of hook. This specimen is shown for its whole length and there is no indication of the other axes except that on the shaft and I am not sure that this structure should be thus regarded. At all events the upper end of the rhabd is simple and smooth.

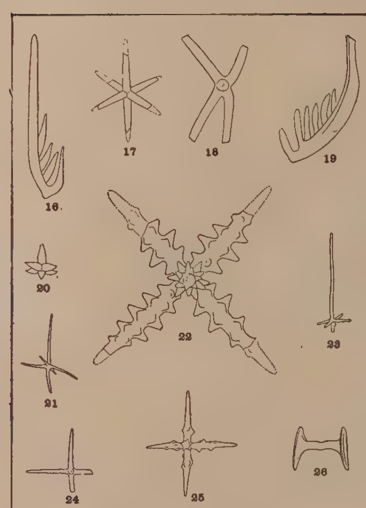
A different type again is presented in figure 13 where the shaft is curved and the prongs of the hook are wide apart and curved outward like the horns of an ox. This is an occasional form seen only in the example presented. There is a series of forms, consisting of straight slender rhabds bearing a trifid hook at one end but no indication of any modification at the other. One of these is of very delicate shape, the terete shaft bearing deeply and narrowly recurved prongs which bend first in and then outward at the top. This pattern of anchorate spicule is shown in figure 10. The usual type, however, is stouter, the prongs shorter, less bent and recurved and these may be either smooth,[figure 9,] or may bear irregularly scattered barbs [fig. 3, 15]. In all these no indication is given of the remnants of the other triaxial arms. Occasionally one finds a dumb-bell shaped spicule with flattened ends which may be regarded as of similar nature as the monaxile diaspid [fig. 26].

To the form of the sponge bodies of which these spicules are the components we can have only a feeble clue. That they were regularly reticulated species with abundant prostalia is indicated by the extensive masses of broken smooth rods. Possibly the root prostalia are represented in part by the anchorate spicules but this is not at all a necessary inference from the presence of the latter for we have shown in our treatise on the Paleozoic Dictyosponges that such spicules are frequent in the vertical spicular bundles of certain species (Physospongia, Cleodictya). The umbels so characteristic of Carbonic dictyosponges seem to be quite absent here and indeed in most every respect of spicular form these Gaspé bodies seem to differ from what we have been led to regard as features of the Dictyospongidae.

Girty has described[1] from the New Scotland beds of the Helderbergian

[1] N. Y. State Geol. 14th An. Rep't. 1895. p. 269, pl. 1, 2.

PLATE B



16, 19 Extreme developments of ancistroid spicules with accessory hooks. 17 A liohexactin of normal style. 18 Like 17, with curved arms. 20 Hexactin with clavate arms. 21 Liohexactin with axis produced into a rhabd. 22 Echinhexactin with spirally arranged thorns. 23 Liohexactin with produced axial rhabd. 24 As 17 or 23. 25 Echinhexactin with very sparse thorns. 26 Dumbbell spicule (monaxial ?).

HEXACTINELLIDS

in Albany county, N. Y., a sponge of uncertain form, apparently subspherical in which the spicules are largely hexacts with smooth and echinate arms. The latter are very like those Gaspé spicules with spirally arranged asperities and though the Helderberg specimens are for the most part highly irregular in this arrangement yet such an one as Girty's figure 23, plate 1, indicates the development of the asperities in uncomplicated spiral lines. Dr Girty has described this species, typical of his genus Lysactinella, as L. gebhardi.

So far then as actual similarities in spicular morphology are involved, the nearest allies in structure which we can now find to our Gaspé hexactinellids are in the Helderbergian of New York.

Receptaculites jonesi Billings

Receptaculites jonesi Billings. Palaeozoic Fossils. 1865. 1:389, fig. 365

Description. The specimens of this species that have been as yet collected are small, turbinate, or depressed conical bodies, from one to two inches across, and from six lines to one inch in hight. The broadest extremity, supposed to be the base, is usually circular, sometimes ovate, gently concave, and with an obtusely rounded margin all round, the thickness of which is from three to five lines. The smaller extremity, or the upper side, is a depressed cone, with an apical angle of 110° to 130°, with an irregularly rounded truncated apex. The grooves of the radial stolons, as shown in the cast of the interior of the ectorhin, radiate straight outwards to the margin, and run upwards over the rounded edge. There are here (on the peripheral edge) four or five grooves in a width of three lines. The grooves of the cyclical stolons are closer together, there being about nine in the width of three lines. From the margin to the apex both systems of grooves become more crowded together, and, at the apex, the ectorhin appears to have been of a somewhat pliable, coriaceous integument. At the apex there are indications, in all the specimens which have this part preserved, of a small irregularly rounded aperture, which is usually depressed, in form, somewhat like the umbilicus of an apple.

Several specimens have been collected which show the internal cavity. It varies slightly in form in different individuals, but is, in general, bell-shaped.

None of the specimens yet seen have the ectorhin preserved, and the form of the plates is not, therefore, yet known. Dedicated to (the eminent English naturalist) T. Rupert Jones.

Locality and formation. Cape Gaspé, in the upper part of the Lower Helderberg group, in beds holding a mixture of Upper Silurian and Devonian fossils.

Collector. Prof. R. Bell.

We have not seen this species.

FAUNA OF THE GASPÉ SANDSTONE

Phacops (Phacopidella) correlator Clarke

Plate 10, figures 17, 18

Phacops correlator Clarke. N. Y. State Mus. Mem. 3. 1900. p. 20, pl. 2, fig. 9

This interesting little species peculiar in the compactness of its cephalic parts pertains to a group represented by Ph. anceps Clarke, of the Decewville or uppermost Oriskany fauna of Cayuga, Ont.[1] Ph. braziliensis Clarke from the Maecurú sandstone of northern Brazil,[2] and Ph. nylanderi from Aroostook county, Me.[3]

Differences are observable in minor details in some of these widely separated specimens but I detect none between those from the Becraft mountain Oriskany described by me as Phacops correlator and the cephala occurring in the Gaspé sandstone. This similarity extends to details of structure and size. The figure given of the Oriskany specimen in the work cited is misleading for the lobation of glabella is actually extremely indistinct and more accurately expressed in the illustration here given.

Locality. Portage road, Gaspé Basin.

Hyolithus cf. aclis Hall

Plate 12, figure 18

See Hyolithes aclis Hall. Palaeontology of New York. 1879. v. 5, pt 2, p. 197, pl. 32, fig. 22–30; pl. 32A, fig. 23–25

A single specimen from the sandstones expresses the characteristic dorsal face of this species with elevated median portion separated from the lateral longitudinal area by low depressions, the whole and more specially the median portion being marked by concentric striae. On removal of the exposed part the opposite face is found to be depressed convex or flat with extended apertural margin. These features which indicate H. aclis accompany the size usual to that species in its occurrence in the Hamilton fauna of New York.

Locality. Portage road, Gaspé Basin.

Tentaculites cartieri nov.

Plate 12, figures 1–4

This is a large species with regularly annulated growth in early stages only but with increase in size the annulations become variable and of

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[1] Archiv. do Mus. nacional do Rio de Janeiro. 1890. 9:16, pl. 1, fig 1.
[2] *Op. cit.* pl. 1, fig. 2, 3.
[3] Clarke. N. Y. State Mus. bul. 107, 1907

obscure outline, all the surface annulations and furrows alike being crossed by very fine regular and equal concentric lines, so that in respect to expression it is not remote from the Oriskany species T. elongatus. The internal cast bears the usual conformation, suggesting a series of inverted and ensheathed cones.

These shells attain a length of 35–40 mm with an apertural width of 4 mm.

Locality. Common in the sandstone on the Portage road, Gaspé Basin.

Species name. Jacques Cartier.

Platyceras gaspense nov.

Plate 14, figure 15

A rather small species with small spiral of 1½ whorls very rapidly expanding so that at the end of the 1½–2 volution the shell is of notable width; thence the whorl becoming free and suberect suggesting the outline of P. thetis Hall of the Hamilton shales but with shorter body whorl and larger spire. The final whorl is compressed but appears to have been subelliptical in cross section. Surface smooth, with one or more longitudinal furrows.

Locality. Gaspé sandstone, Portage road, Gaspé Basin.

Holopea gaspesia nov.

Plate 15, figures 1–7

Shell rather small. Spire short, whorls 3–4, somewhat flattened beneath. Expansion rapid, sutures sharp but not deep though the sutural region may be flattened; nonumbilicate. Stoma subcircular. Surface with fine and close concentric lines which about the sutures are gathered into coarse raised radii which are lost before traversing one half the whorl. Some specimens show a series of two or more revolving raised lines on the body at and below the periphery and two of these may be the boundaries of a slit-band, though this feature can not be determined from the sandstone casts. This, however, does not appear to be a prevalent character of the species.

Dimensions. An average specimen has a hight of 10 mm and a basal diameter of 9 mm.

Locality. This is the commonest of the gastropods in the Gaspé sandstone in the Portage road outcrops, Gaspé Basin.

Holopea wakehami nov.

Plate 15, figures 9–11

Shell small, compact, with depressed spire, full ventricose body whorl and small obscure earlier whorls, suture impressed, hight to width as 4 to 3. Aperture broadly oval, entire; inner lip thickened and slightly excavated. Whorls 4. Surface smooth or covered with very fine concentric lines. Average dimensions, hight 7 mm, width 5 mm. Distinguished from H. gaspesia by its rounder, more compact form, fuller whorls and more depressed spire. This species is in some of its expressions almost a miniature of the common Macrochilus hamiltoniae Hall of the Hamilton shales of New York.

Locality. Common at the Portage road.

Species name. Commander Wakeham of *La Canadienne*, inspector of fisheries in Gaspé.

Callonema cf. **bellatulum** Hall

Plate 15, figure 8

See Callonema bellatula Hall. Palaeontology of New York. 1879. 5:51, pt 2, pl. 14, fig. 10–15; pl. 28, fig. 18, 19

This is a species characterized by a somewhat elevated spire, the whorls along the suture depressed or flattened and the surface covered by sharp concentric lines. It seems to resemble in all its visible details the species referred to which was described from the Onondaga limestone of Columbus, Ohio.

Locality. Portage road, Gaspé Basin.

Pleurotomaria sulcomarginata Conrad

var. **leclercqi** nov.

Plate 16, figures 15, 16

See Hall, Palaeontology of New York. 1879. 5: 69, pt 2, pl. 19, fig. 8–17

From the expression of the somewhat variable specimens of this species in the calcareous and arenaceous Hamilton fauna of New York, the Gaspé shells vary (1) in respect to size, being smaller, (2) in the matter of the form of the spire, which is somewhat more turreted, (3) in the more suppressed revolving knotted ridge near the sutures and (4) in the greater elevation of the slit band on the early whorls. Agreement is evident in the relative proportions of the shells, the broad upper slope of the whorls, markedly strong concentric line, the elevation of the slit-band above the suture and the smooth or concentrically lined lower surface of the whorls.

Locality. Not common at Gaspé Basin, Portage road.

Varietal name: Chrestien Leclercq, Recollet missionary in Gaspé, 1675, and author of *Nouvelle Relation de la Gaspesie*, 1691.

Euphemus ? quebecensis nov.

Plate 17, figures 19-22

To this well known Carbonic genus I refer with hesitancy flat or discoid, involute, horizontally coiled shells having a goniatitic aspect, the final whorl deeply overlapping the preceding and closing the umbilicus. The whorls are narrow but deep, abruptly curved on the periphery; the stoma expanded but not explanate. The surface is marked by regular simple and continuous elevated revolving lines which become crowded toward the aperture. There is no evidence of a slit-band. The shell has a diameter of 10 mm.

This species represents a very unusual type of structure for a Devonic bellerophontid but is provisionally placed in this association.

Locality. Gaspé sandstone, Portage road, Gaspé Basin.

Tropidocyclus brevilineatus (Conrad)

Plate 17, figures 7-16

Bellerophon brevilineatus (Conrad) Hall. Palaeontology of New York. 1879. 5: 107, pt 2, pl. 26, fig. 5-7

The shell identified by Hall with Conrad's description attains larger size than T. rotalinea and is at once distinguished therefrom by the sharply elevated retrally curved concentric striae which are not divided by a slit-band. The trilobed expression of the exterior is better defined in the sandstone specimens than in those from the shales of New York as are likewise all exterior markings. The concentric lamellose lines are crossed by fine interrupted revolving lines most distinct on the lateral lobes. Comparison with the types of Hall's description leaves no doubt as to identity to the finest details.

Localities. Portage road, Gaspé Basin and in the Hamilton shales of Norton's Landing, and Tichenor's Point, N. Y.

Tropidocyclus rotalinea (Hall)

Plate 17, figures 3-6

Bellerophon rotalinea Hall. Palaeontology of New York. 1879. v. 5, pt 2, p. 115, pl. 26, fig. 8

This little species, singularly and distinctly characterized by its highly compressed and deeply trilobed surface, its projecting keel, carrying a slit-band and its revolving elevated surface lines, is extraordinarily rare in the Hamilton (Ludlowville) shales of New York, the type specimen being the only example known, but in the Gaspé sandstone it is one of the commoner gastropods. It differs herein nowise from the New York species even in size.

Locality. Gaspé sandstones, Portage road, Gaspé Basin; and in the Hamilton shales at Norton's Landing, Cayuga lake, N. Y.

Bellerophon sp.

Plate 17, figures 23, 24

A single broad backed specimen of medium size but very poorly preserved indicates the presence of a species similar to B. leda Hall (Hamilton) with the surface marked by fine revolving lines. It can not at present be more closely determined.

Locality. Portage road, Gaspé Basin.

Aviculopecten sp.

A single left valve indicates the presence here of a fairly large species of the genus, which does not, however, lend itself to exact comparisons.

Locality. Portage road, Gaspé Basin.

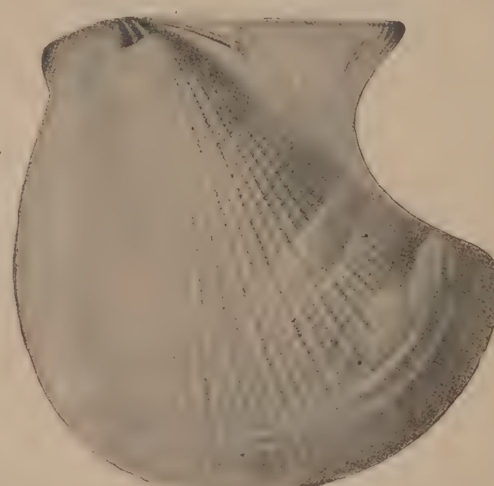
Actinopteria (Pterinea) fronsacia nov.

Plate 19, figure 6

This is a species having the size and proportions of the common and well known A. boydi[1] of the Hamilton fauna of New York but somewhat more erect and with a larger auricle. Its surface is marked by quite regularly alternating radii and these are crossed by imbricating concentric lines which are closely crowded together and crenulated fore and aft. In A. boydi the radial riblets are of more uniform size and as usually preserved in the shales show only inconspicuous evidence of the lamellose concentric lines here present. More closely allied in ornament and in form is the A. eschwegii Clarke,[2] from the Lower Devonic Maecurú sandstone of the Amazonas.

Locality. Portage road, Gaspé.

Specific name. Richard Denys de Fronsac, son of Nicholas Denys and proprietor of the Miramichi country, 1690.



Actinopteria (Pterinea) fronsacia. Sculpture cast of a large left valve showing pterineoid hinge structure. Collection of McGill University.

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[1] *See* Hall. Palaeontology of New York. v. 5, pt 1, p. 84, pl. 19, fig. 2–24, 26–30; pl. 84, fig. 16, 17.

[2] Archivos do Mus. Nac. Rio de Janeiro. 1899. 10: 45, pl. 5, fig. 9.

Grammysia canadensis Billings

Plate 23, figure 13

Grammysia canadensis Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 51, pl. 4, fig. 3

Original description. Transversely subovate; posterior extremity obliquely truncated; dorsal and ventral margins subparallel, slightly converging posteriorly; umbones moderate, rounded, occupying about one third the hight; most projecting point of the anterior extremity situated at about half the hight of the shell. The upper posterior angle is obtusely rounded, about one fifth the length in front of the lower angle, which latter is narrowly rounded or obtusely angular, and just above the line of the ventral margin. The posterior edge, between these two angles, is gently convex, somewhat straight in the middle. Dorsal margin, slightly arched, almost straight, gently curving over the posterior angle, more abruptly rounded at the umbones. Ventral margin, nearly straight or slightly concave in the posterior two thirds; the remainder, at first gently, and then somewhat abruptly rounded up to the anterior angle, between which and the umbo there is a concave notch. Length, about twice the hight; the greatest hight a little in front of the mid-length. The valves are moderately convex, obliquely flattened from the umbones to the posterior half of the ventral margin. A rounded ridge commences at the beaks, and runs obliquely downwards and backwards towards the middle of the ventral margin, before reaching which it becomes obsolete. On each side of this ridge there is a narrow sulcus. A moderately strong rounded angulation extends from the beak, just below the dorsal margin, to the lower posterior angle. The beaks appear to be small and closely incurved.

Surface covered with concentric ridges from one half a line to two lines wide each. On the umbones, and on the anterior half of the shell, these are rounded, but towards the posterior extremity, they become flattened and sublamellose at their lower edges.

Length of the largest specimen collected, thirty-three lines; hight, nineteen lines; depth of a single valve, six lines.

Locality. Gaspé; lower part of the Gaspé sandstone.

This species has been found by me on the Gaspé Mountain and also on the south side of the Southwest Arm, 3 miles from Gaspé Basin. It is very closely allied to G. hamiltoniae, a common shell in the sandy Hamilton shales of central and eastern New York.

Goniophora sp. ?

A small well defined member of this genus occurs in the sandstone.

Locality. Portage road, Gaspé Basin.

Modiella pygmaea (Conrad)

Plate 23, figures 6, 7

Pterinea pygmaea Conrad. Acad. Nat. Sci. Phila. Jour. 1842. 8: 251, pl. 13, fig. 15

Modiella pygmaea Hall. Palaeontology of New York. 1885. v. 5, pt 1, p. 514, pl. 76, fig. 9–20

The specimens of this species at Gaspé preserve all the characteristics of typical forms, in size, contour and surface markings. The shell is common throughout the Hamilton shales of New York.

Locality. Portage road, Gaspé Basin.

Modiella modiola nov.

Plate 23, figures 1-5

This is a more elongate, more slender and generally larger shell than M. pygmaea, the posteriorly expanded and convex body of the shell being narrower, the byssal sulcus less deep and the anterior fold very much reduced in diameter. The shells are thus subacuminate or modioloid and very obliquely arcuate. Average examples have a length of 19-24 mm.

Locality. Portage road, Gaspé Basin.

Phthonia cylindrica Hall

Plate 22, figure 13

Phthonia cylindrica Hall. Palaeontology of New York. 1885. v. 5, pt 1, p. 473, pl. 78, fig. 1-4

This smooth elongate and semicylindrical member of the genus Phthonia is clearly represented by small shells, not attaining the dimensions of the New York species. It has been elsewhere recorded only in the Hamilton shales.

Locality. Gaspé sandstone, Portage road, Gaspé Basin.

Sphenotus truncatus (Conrad)

Plate 22, figures 9-12

Cypricardites truncatus Conrad. Acad. Nat. Sci. Phila. Jour. 1842. 8: 244, pl. 12, fig. 17

Sphenotus truncatus Hall. Palaeontology of New York. 1885. v. 5, pt 1, p. 394, pl. 65, fig. 1, 4-6

This is an elongate shell with smooth subconcave median portion, short umbonal ridge and broad postumbonal slope traversed by a low intermediary ridge. Specimens in the Gaspé sandstone are not distinguishable from typical forms occurring in the Hamilton shales of central and eastern New York.

Locality. Portage road, Gaspé Basin.

Schizodus appressus (Conrad) Hall

Plate 23, figure 11

Schizodus appressus (Conrad) Hall. Palaeontology of New York. 1885. v. 5, pt 1, p. 449, pl. 75, fig. 3-9

A single very typical example of the species is present. Schizodus appressus is a common species of the Hamilton fauna throughout localities of western New York.

Locality. Portage road, Gaspé Basin.

Palaeopinna flabellum Hall ?

See plate 21, figures 1-5

We have noticed the presence of this Oriskany species in the St Alban and Grande Grève limestones and we have before us a fragment from the Gaspé sandstone which suggests the same species. It is smaller than the others but presents the similar characters of hinge and the broad posterior extension.

Locality. Portage road, Gaspé Basin.

Nuculites triquetrus (Conrad) Hall

Plate 24, figures 7-10

Nuculites triqueter (Conrad) Hall. Palaeontology of New York. 5: 326, pt 1, pl. 47, fig. 17-28; pl. 91, fig. 8-10

This is the most abundant of the pelecypods in the sandstone and is in all respects identical with the New York specimens, which are common at many outcrops of the Hamilton shales.

Locality. Portage road and on the south side of the Southwest Arm, 3 miles from Gaspé Basin.

Palaeoneilo maxima (Conrad) Hall

Plate 24, figures 4, 5

Palaeoneilo maxima (Conrad) Hall. Palaeontology of New York. v. 5, pt 1, p. 335, pl. 48, fig. 29-38

A single external and internal cast of this species abundant in the more arenaceous shales of the Hamilton group of New York has been found in the Gaspé sandstone.

Locality. Gaspé Mountain.

Palaeoneilo cf. **constricta** (Conrad)

Plate 24, figure 6

See Palaeoneilo constricta (Conrad) Hall. Palaeontology of New York. 1885. v. 5, pt 1, p. 333, pl. 48, fig. 1-16; pl. 51, fig. 17

Shells having the short erect figure and broad posterior incurvature and fold of this species occur in the sandstone. Palaeoneilo constricta is found in the Hamilton shales of central and western New York and in the soft Angola (Portage) shales of Lake Erie.

Locality. Portage road, Gaspé Basin.

Leda brevirostris Hall

Plate 24, figures 1–3

Leda brevirostris Hall. Palaeontology of New York. 1885. v. 5, pt 1, p. 329, pl. 47, fig. 38–41

A few specimens have been found, internal and external casts, which cannot be readily distinguished from this species from the Hamilton shales of New York.

Locality. Portage road, Gaspé Basin.

Lunulicardium ? convexum nov.

Plate 23, figure 12

Cardiiform, beak anterior, outline obliquely orbicular. Surface convex, elevated about the umbo, which is full and overarched, abruptly deflected on the anterior slope. Anterior marginal curve at first concave, thence rounding rather abruptly at the extremity, posterior curve much broader and postlateral surface somewhat expanded. Surface bearing round, threadlike and simple radii separated by very narrow sulci. On the single right valve observed there are 26–28 of these radii which extend over the entire surface.

Length and hight equal.

This is a small shell which, with the general aspect of a Lunulicardium, fails to reveal the critical structural features of that genus.

Locality. Portage road, Gaspé Basin.

Cryptonella sp.

A single internal cast of a ventral valve from the Portage road.

Rennsselaeria ovoides (Eaton) Hall

var. **gaspensis** nov.

Plate 25, figures 12–14, 18; plate 26, figures 1–3

See under Grande Grève fauna, p. 164

Common at the Portage road, and on Gaspé Mountain.

Eatonia peculiaris Conrad

Plate 29, figures 1, 2

This species I have found in a few entirely characteristic examples on the south side of the Southwest Arm of Gaspé Bay about three miles from Lobster Point. The rock itself was found loose but the outcrops are at hand and as they lie only a comparatively short distance from the Haldimand

axis I infer that they lie low in the series. With these were associated the limestone blocks bearing Productus comoides referred to on page 97.

Leptocoelia flabellites Conrad

Plate 29, figures 23–26, 28

At all localities, specially on the Portage Road, in examples which depart in no measure from the typical forms of the species.

Spirifer gaspensis Billings

Plate 31, figures 29–38

Spirifer gaspensis Billings. Palaeozoic Fossils. 1874, v. 2, pt 1, p. 44, pl. 3, fig. 8, a, b

Original description. Shell varying from semicircular to transversely semielliptical, hinge line much extended; often twice the length of the shell; in some specimens shorter, one fourth or only one fifth greater than the length. In the wide specimens the cardinal angles are acute, varying from 40° to 90° sometimes a small portion of the sides, usually about one line in length, at right angles to the hinge; the remainder of the sides, around to the mesial fold of sinus, uniformly and gently rounded. In those with a short hinge, the side, in the upper half of the shell, are straight or slightly concave, and at about 90° with the hinge line, the front half rounded. Ventral valve strongly convex, most elevated about the middle of the upper half, or a little above that point; cardinal angles more or less flattened; umbo prominent; beak small, strongly incurved, a well defined mesial depression, concave or subangular in the bottom without ribs, extends from the beak to the front margin where it strongly elevates the edge of the dorsal valve, and, extending the whole width, slightly concave, one or two lines high at the beak. Foramen about three lines wide in a specimen of average size; deltidium convex, apparently not entirely closing the foramen. Dorsal valve with a strongly elevated mesial fold, without ribs; on each side of the fold moderately convex, compressed near the cardinal angles; umbo and beak curved down to the area, which is small, and apparently nearly in the plane of the margin, but sloping a little outwards. On a side view, the outline of this valve rises, with a more or less abruptly rounded curve, to about one third the length of the valve and then becomes nearly parallel to the lateral margin and continues to the front with a gently convex curve. The front margin, owing to the great elevation of the mesial fold, is nearly squarely truncated, as seen in the side view.

Surface with from twelve to eighteen simple undivided ribs, on each side of the fold and sinus. These are often crossed by concentric zigzag imbricating lines of growth. In the casts, the ribs vary from acutely angular to rounded angular. When the shell is preserved the ribs are obtusely angular.

In the casts of the interior (the condition in which the specimens are usually found in the sandstone) the mesial fold of the dorsal valve often exhibits a fine groove along the middle, as if impressed by a thin septum. This is not visible in all the specimens, especially those that are slightly worn. On each side of the umbo of the ventral valve there is (in the casts) a short deep fissure from one to three lines in length.

Width of a large specimen on the hinge line, twenty-four lines; average width, eighteen lines. The ribs vary slightly in size in different specimens. There are usually five or six in the width of six lines, near to the fold or sinus. The mesial fold and sinus are from four to six lines wide at the front margin. The fold is often elevated six lines at the front.

This species belongs to the group of S. murchisoni but its differentials are pretty well defined. It is a shell more extended on the hinge with more abundant closer and sharper plication, sharper fold and sinus and in respect to surface ornament it has distant and very sharp varices which are fringed with fimbriae. The shell may be compared in respect to form and number of plications with S. submucronatus Hall and S. cumberlandiae Hall from the Oriskany of Maryland, but it differs from both in sharpness of plication, fold and sinus and in the surface details. Sinus and fold are persistently free of plication or furrow. On a careful study of all the forms pertaining to this group, S. gaspensis will doubtless be found a clearly defined expression of the type of structure, one which maintains its characteristics with pertinacity. I find associated with shells having the foregoing characters other Spirifers generally of larger size and in which the plications are much flatter and apparently smooth though not differing materially in number. These present a different aspect to that of S. gaspensis but it is quite possible that they are waterworn shells.

Localities. Billings stated that the species is very abundant in the Gaspé sandstone, Gaspé Bay, and also quoted it from Split Rock, Percé. We have found it common at most outcrops of the sandstone at and near Gaspé Basin, but the Percé shell which Billings identified with it, is doubtless S. murchisoni.

Cyrtina hamiltonensis Hall

Cyrtina hamiltonensis Hall. Palaeontology of New York, 4: 268, pl. 27, fig. 1–4; pl. 44, fig. 26–33, 38–52

A single indubitable specimen of the common Hamilton shale species has been observed at the Portage road.

Athyris hera nov.

Plate 34, figures 13, 14

The sandstones at Gaspé Basin afforded casts of ventral valves, one of them of noteworthy size, of subcircular outline, considerably arched at the umbo but depressed on the slopes, and with a narrow deep and evenly rounded median sinus; the surface of the valve bears only the concentric lines of growth and with very fine radial striae visible only in the sinus. The valve has a length and width of 45 mm.

The larger specimen suggests a Spirifer allied to the rare type of S. laevis of the Ithaca (Portage) fauna of New York, though more orbicular and with more pronounced sinus. That species has been regarded as a fimbriated shell, but the fine radial lines of this specimen have less the

character of fimbriae than of the lines on Spirifer radiatus Sow. which, without plications, is the starting point of a considerable series of radiate-plicate shells. The general approach of both our specimens to species of Athyris, such as A. spiriferoides of the Hamilton fauna indicates a more probable relation therewith.

Leptostrophia blainvillii Billings (sp.)
(=Leptostrophia perplana Conrad?)

Plate 36, figures 19–24

Strophomena blainvillei Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 28, pl. 2, fig. 1, a–b; pl. 3, fig. 1

Original description. Shell semielliptical, hinge line equal to a little less or a little greater than the width; sides in the posterior half usually gently concave, sometimes straight or gently convex; front broadly rounded, sometimes straightish in the middle; width from one eighth to one sixth greater than the length.

Ventral valve gently convex; greatest elevation about one third the length from the beak; cardinal angles compressed; the umbo broadly obtuse; beak scarcely distinct from the cardinal edge; area flat, inclined at an angle of about 40° to the plane of the lateral margin, striated and with the edge denticulated its whole length; dorsal valve nearly flat, slightly concave; area very narrow; both valves usually with several concentric wrinkles or rugae of growth.

Surface covered with fine, rounded or subangular radiating striae, of a very uniform size; about twelve in the width of two lines. When slightly exfoliated the grooves between the elevated striae are seen to be regularly pitted or punctated, from six to eight punctures in one line.

In the interior of the ventral valve the area occupied by the muscular impressions is of a subtriangular shape, and extends from the beak about two thirds of the length. The front of this area is generally broadly rounded; the two upper sides converging with a concave curve to the beak. The space on each side of the upper part of the area is strongly tuberculated, becoming gradually smooth towards the cardinal angles. A thin mesial septum extends from the beak two thirds the length of the shell. For the length of about a line from the beak the septum is much thickened, leaving in the cast of the interior a short, deep fissure, as shown in figure 1. On each side of this fissure there are two tubercles, more or less elevated, which are the casts of the cavities in the shell, for the reception of the divaricator processes. The divaricator scars are divided into a number of lobes, usually five or six, but often more. The occlusors are rather small, and extend from the thickened part of the septum about one third the length of the divaricators. All around the sides and front of the muscular area the casts of the interior are striated, the striae often becoming coarser as they recede from the margin.

The casts of the interior of the dorsal valve exhibit two ovate pits close to the beak [fig. 1b], the impressions of the divaricator processes. From these two pits the impression of a short septum extends, ending in a point at about three lines from the beak. The occlusor scars are situated on each side of this septum, but their form is not exhibited in any of the specimens collected. The shell on each side of the scars is coarsely tuberculated, smooth along the hinge line and at the cardinal angles. The divaricator processes, as shown by their impressions, are short, erect, slightly sloping backwards, but diverging laterally.

None of the specimens are sufficiently perfect to exhibit all the details of the area. In some the casts show that there is a small triangular pit beneath the beak, as there is in S. magnifica.

Width on the hinge line from ten to sixteen lines. Length eight to fourteen lines. Specimens two inches wide are sometimes met with.

Mr Billings observed that the only reason he found for distinguishing this shell from Leptostrophia perplana was the larger muscle scars. Leptostrophia perplana as it occurs in the faunas of the Onondaga, Hamilton and Ithaca stages is seldom so large a shell at full growth as L. blainvillii, but the two are so closely similar in all details of structure that I very much doubt the propriety of retaining a distinction in name. This similarity is seen even in the minutiae of surface, interior and hinge. Leptostrophia blainvillii is very abundant in the Gaspé sandstone and very frequently its surface is covered by a growth of Hederella blainvillii, which is seen very rarely indeed on any other organism.

Localities. Mr Billings gives his localities as the lower part of the Gaspé sandstone at Gaspé. Our specimens show the species to be of frequent occurrences in the outcrops of the Portage road, Gaspé Basin.

Orthothetes (Schuchertella) becraftensis Clarke

See under Grande Grève fauna, p. 199

Not uncommon at Portage road, Gaspé.

Chonetes billingsi nov.

See under Grande Grève fauna, p. 209

A single specimen from the Portage road.

Chonetes hudsonicus Clarke

Plate 45, figures 6–15

Chonetes hudsonicus Clarke. N. Y. State Mus. Mem. 3. 1900. p. 49, pl. 7, fig. 1–6

In the work cited the writer referred to the fact that Ch. hudsonicus, found hitherto in New York only in the calcareous Oriskany of Becraft mountain, occurs in the Gaspé sandstone. This species was described as follows:

The shell is of medium or small size, transverse in outline; hinge line marking the greatest width of the shell; lateral margins subparallel for a short distance and rounding rather abruptly to a nearly transverse anterior margin. Surface of the pedicle valve quite uniformly convex, with a faint median sinus seen only over the anterior portion of the valve. The surface striae are fine, round and close together, with very narrow interspaces. They increase rapidly and irregularly by bifurcation and implantation. Very fine, concentric lines are sometimes visible with favorable preservation. The cardinal spines are two or three in number on each side of the beak and are directed outward.

On the brachial valve a fold to correspond to the obscure median sinus of the pedicle valve is not always to be seen. So far as observed, the multiplication of the striae of this valve seems to be wholly by bifurcation. With respect to their interior characters, both valves present normal structure with a considerable development of the median septum in the pedicle valve.

The Gaspé sandstones afford in some abundance a series of shells among which we observe that the smaller members express clearly and fully the features of Ch. hudsonicus. It is unnecessary to further characterize these individuals except to add that (1) they, like the larger shells, seldom reveal any evidence of cardinal spines which are likewise seldom seen in Ch. hudsonicus, and (2) it is possible to detect in them faint indications of crenulations along the hinge of the pedicle valve, a feature which has not been noted in the Becraft mountain shells and which even here would hardly excite attention were it not for its manifest relation to more striking development in associated shells. These smaller shells having clearly all the characters of Ch. hudsonicus definitely restrict the application of this term in this series of Chonetes.

It is evident however that the limit of specialization expressed by the New York shell is far overpassed in the Gaspé series. By the most gradual development accompanied by an apparently regular increase in size the shells attain differentials not apparent in the Ch. hudsonicus stage. These differences are seen in the slow but eventual alteration of outline from a transverse to a more elongate form, accompanied as already stated, by concomitant increase of size; in the strong development of the cardinal denticulations. At the same time there is no deviation in contour or ornament of the exterior. To the denticulations of the hinge line special attention may be directed. In the eventual or terminal expression of this feature we find this denticulation to consist of stout, strong processes, free at their extremities, largest near the deltidium and running almost, if not quite, to the cardinal extremities. The upper part of the cardinal area remains smooth, the denticulations terminating rather abruptly at or close to the hinge line. This is a structure altogether similar to that in Stropheodonta and its immediate allies, and in this instance has no apparent connection with the cardinal spines or spine tubes. We have observed that the only evidences of spines present in the Ch. hudsonicus stage are occasional blunt bases or tube fillings and in the larger shells even these have been found wanting.

We are presented in this case with a most forcible example of a species in one marine province passing beyond the limitation of ontogenic development acquired by that of another. The former is the whole of which the described and delimited latter is relatively but a part though complete in itself. To express the former in terms of the already delimited species we propose to apply the term hudsonicus as above used, to that portion of

the series or stage of development in which the correspondence therewith is complete. The latter terms of the series represent development beyond that attained by the type, it is metatypical. Hence we may with propriety, in instances of this kind which may arise in the comparison of provincial faunas, employ the term metatype; thus

Chonetes hudsonicus metatype **gaspensis**

Billings observed the presence of cardinal denticulations in Ch. melonicus and Hall has shown that crenulations exist on the hinge line of Ch. arcuatus, Onondaga limestone [*see* Palaeontology of New York, 1867, 4: 119, pl. 20, fig. 7, e, f] but explained them as due to the projection of the cardinal spine tubes. Whether or not this can be made to account for their existence in that species it would hardly meet the condition in the Gaspé specimens.

The variation in these expressions of Chonetes within the series above described, may be taken as an indication of the prolixity which would attend development at a center of migration. Chonetes hudsonicus alone, so far as our knowledge goes, expresses that part of this line of development which has wandered far.

Localities. Portage road, 3 miles west of Gaspé Basin and loose on the east side of the Southwest Arm of Gaspé Bay.

Chonostrophia dawsoni Billings

Plate 46, figures 14–24

Chonetes dawsoni Billings. Palaeozoic Fossils. 1874. v. 2, pt 1, p. 18, fig. 8

Cf. Chonostrophia complanata Hall. [*See ante* p. 210]

Billings's description of this species was as follows:

Shell semielliptical; width about one third or one fourth greater than the length; cardinal angles usually somewhat less than a right angle; sides, for about one third or one half the length below the hinge line, nearly straight, or gently convex; slightly converging towards each other, and then gradually and uniformly curving to the front margin which is broadly rounded.

Ventral valve gently concave, or nearly flat; the umbo slightly elevated; beak scarcely distinguishable from the cardinal edge. On the latter are from six to ten short spines on each side of the beak, sloping outwards at an angle of from 45° to 60°. The cast of the interior of this valve shows that there is a thin elevated ridge or septum, extending from the beak along the median line, about half the length of the shell. Two other obscure ridges diverge from the beak outwards, forming an angle of between 30° and 40° with the hinge line. The area has not been seen, but its impression shows that it is of moderate size, and inclined at an angle of about 45° to the plane of the lateral margin. Foramen triangular, the width apparently a little greater than the hight.

The dorsal valve has not been seen.

The surface is covered with fine subangular radiating striae which increase by fission and intercalation. Of these there are from seven to nine in the width of one line. There

is also a set of minute concentric striae, between thirty and forty in the width of one line.

The following are the dimensions of several specimens in lines, the first number indicating the width of the hinge line, and the second the length. 16—12, 12—8, 10—6, 11—7, 12—8, 14—10.

This species differs from all others of the genus, yet discovered in Canada, by having the ventral valve concave instead of convex.

Locality and formation. In the Gaspé sandstone at Gaspé, and in the limestone at Split Rock, Percé. Lower Devonian.

While this shell in its variations in outline from transverse to somewhat elongate, degree of echination, the occasional presence of a low median fold on the ventral valve and other radial sinuosities, agrees with the Ch. complanata of the calcareous Oriskany of New York, yet our specimens show that the striation of the surface is finer and apparently uniform in most cases. Some of our casts show alternation or fasciculation about the margins of the valves, but even in such cases less pronounced than in Ch. complanata. There is also a less degree of reversed convexity in the sandstone specimens which have been subjected to but little compression, and further, in but few are the muscular markings so well shown as on that species. All of these features serve to clothe the species with distinction though we must admit the distinction is rather refined and the two shells most closely related. In the character of its striation the shell approaches the Ch. helderbergiae Hall and Clarke, from the Helderbergian (New Scotland beds) of New York, and its relation to the Ch. complanata of Grand Grève is much the same as that of Ch. helderbergiae to the Ch. complanata of New York.

The shells vary a good deal in size, an average specimen having a length of 18 mm and a width along the hinge of 26 mm. Large examples measure 30 by 45 mm, surpassing the dimensions of the large forms of Ch. complanata found in the Oriskany sandstone of Union Springs, N. Y.

Locality. Rather common in the sandstones, on the Portage road 3 miles west of Gaspé Basin and loose on the east side of the Southwest Arm. We regard the specimens which Billings referred to as occuring at Percé, as belonging to the species, Ch. complanata.

Chonostrophia complanata Hall

See Grande Grève fauna, p. 210

Rare at the Portage road.

Dalmanella penouili nov.

Plate 43, figures 1–4

This is a small circular shell without median depression or elevation but with an elevated ventral valve and high cardinal area, simulating in this regard an Orthothetes but without the deltidium and having a short hinge line. The species is of the type of the Orthis lepidus Hall of the Hamilton shale fauna but is of larger size than that little species is known to attain. The surface of the valves is finely striate, the elevated radial lines differing in size a few being considerably larger than the rest.

Dimensions. The average among several examples is a width of 8 mm and length of 7 mm.

Locality. Portage road.

Species name. Among the early French writers Gaspé Bay was the Baie de Penouil.

Hederella blainvillii sp. nov.

Plate 48, figure 2

This very interesting bryozoan encrusts the shells of Leptostrophia blainvillii and so far as our observation has extended seems to attach itself always to the ventral or upper valve at an early stage in the life of the brachiopod and grow outward from the parent cell in all directions keeping the apertures of the cells at or just a little distance above the margins of the shell. This habit evinces a true commensal condition not often shown in other cases of attached bryozoa; the water currents set up by the ciliated mantle of the brachiopod have helped to feed the members of the bryozoan colony, most of which stand in an attitude of readiness for this service. This species occurs with extraordinary frequency on these brachiopod shells and seems to grow on no other save for an occasional simply branched stock on an upper valve of Chonetes hudsonicus. Herein is another such striking illustration of organic associations as we find exemplified in the attachment of the coral Pleurodictyum problematicum to Chonetes sarcinulatus and P. stylopora to the gastropod Loxonema hamiltoniae. It is further exemplified in Hederella ramea which I have described from the Oriskany of Becraft Mountain, N. Y. and which elects attachment to Leptostrophia oriskania, always keeping its apertures toward the opening of the shell valves. From that species H. blainvillii differs in its much more rapidly branching zoarium and consequent shorter cells, producing a fuller and denser stock.

Locality. Wherever Lept. blainvillii occurs in the Gaspé sandstone.

Tabular statement of the distribution in regions of eastern America of the Devonic species herein considered

x = identity. * = affine

			GRANDE GRÈVE BEDS						HELDERBERGIAN			ORISKANY					
	St Alban beds	Cape Bon Ami beds	Forillon	Percé	Gaspé sandstone	Dalhousie beds	Chapman sandstone	Moose River sandstone	Montreal	New York	Maryland	Eastern New York	Central New York	Decewville	Maryland	Onondaga limestone including Schoharie grit	Hamilton beds (Skaneateles, Moscow and Ludlowville shales)
Fishes																	
1 Machaeracanthus sulcatus *Newberry*					x												
2 Ctenacanthus					x												
3 Cephalaspis dawsoni *Lankester*					x												
Annelids																	
4 Gyrichnites gaspensis *Whiteaves*					x												
5 Serpulites *sp.*			x			x											
6 Spirorbis latissimus			x														
7 Autodetus beecheri *Clarke*			x									x					
8 Cornulites cingulatus *Hall*			x							*							
9 Tentaculites elongatus *Hall*			x	x								x	x				
10 T. leclercqius				x				x									
11 T. cartieri					x												
Eurypterids																	
12 Pterygotus					x	x											
Trilobites																	
13 Phacops logani *Hall*	x		x				*			x	x	x					
14 Phacops logani *var.* gaspensis			x			x									*		
15 P. (Phacopidella) correlator *Clarke*				x			*					x		*			
16 Dalmanites griffoni	x																
17 D. coxius	x																
18 D. micrurus *Green*			x			x	*			x							
19 D. emarginatus *Hall*			x													x	
20 D. dolbeli			x									*		*		*	
21 D. whiteavesi			x														
22 D. phacoptyx *H. & C.*			x									x				x	
23 D. lowi			x														
24 D. gaveyi			x														
25 D. perceensis				x													
26 D. veiti			x														

Tabular statement of the distribution in regions of eastern America, etc. (*continued*)

			GRANDE GRÈVE BEDS						HELDERBERGIAN			ORISKANY					
	St Alban beds	Cape Bon Ami beds	Forillon	Percé	Gaspé sandstone	Dalhousie beds	Chapman sandstone	Moose River sandstone	Montreal	New York	Maryland	Eastern New York	Central New York	Decewville	Maryland	Onondaga limestone, including Schoharie grit	Hamilton beds (Skaneateles, Moscow and Ludlowville shales)
27 D. (Probolium) esnoufi			x														
28 D. (P.) biardi				x						*							
29 Bronteus barrandii *Hall*	x					*				x							
30 Proetus phocion *Billings*			x	x												*	
31 Cordania gasepiou		x		x													
32 C. becraftensis *Clarke*			x									x					
33 C. cyclurus (*H. & C.*)	x									x							
34 Lichas bellamicus			x														
35 L. (Gaspelichas) grandegrevensis			x													*	
36 Ceratocephala robinia			x	x						*		*					
Entomostraca																	
37 Beyrichia kloedeni *McCoy var. cf.* acadica *Jones*			x			x	x										
38 Bythocypris *sp.*			x														
39 Aparchites			x														
Phyllocarida																	
40 Tropidocaris belli (*H. Woodward*)					x												
Cephalopods																	
41 Kionoceras rhysum	x	x	x			x											
42 K. champlaini			x														
43 Orthoceras			x														
44 Cyrtoceras albani	x									*							
45 C. *sp.*			x														
Pteropods																	
46 Hyolithus richardi			x														
47 H. oxys			x														
48 H. *cf.* aclis *Hall*					x												x
49 Conularia lata *Hall*	x		x									x	x				
50 C. *cf.* desiderata *Hall*			x							x							
51 C. " *var.* tuzoi				x						*							
52 C. penouili			x														

Gastropod:																	
53 Platyceras *cf.* unguiforme *Hall*		x								x							
54 P. *cf.* fornicatum *Hall*			x													x	
55 P. *cf.* nodosum *Conrad*			x													x	
56 P. paxillifer			x									x					
57 P. tortuosum *Hall*			x	x													
58 P. lejeunii			x														
59 P. guesnini				x													
60 P. leboutillieri				x			x										
61 P. gaspense					x												*
62 P. *sp.*				x													
63 P. *sp.*					x												
64 P. (Orthonychia) belli				x													
65 Holopea *cf.* antiqua *Vanuxem*			x			*				x							
66 H. wakehami					x												
67 H. gaspesia					x												
68 Lophospira bilirata (*Hall*)	x									x							
69 Coelidium hebe (*Billings*)			x														
70 C. egregium (*Billings*)			?														
71 Pleurotomaria labrosa *Hall*	x									x							
72 Eotomaria cartieri	x																
73 E. voltumna (*Billings*)			?														
74 E. lydia (*Billings*)			x														
75 E. delia (*Billings*)			x														
76 E. ? rotula			x														
77 P. sulcomarginata *Conrad var.* leclercqui					x												*
78 Poleumita princessa (*Billings*)		x															
79 Trochonema lescarboti				x													x
80 Callonema *cf.* bellatulum *Hall*					x												
81 Diaphorostoma affine (*Billings*)			x	*				*				*	*	*	*		
82 D. desmatum *Clarke*			x					x				x			x		
83 D. perceense			*	x								*	*	*	*		
84 D.			x														
85 Strophostylus expansus *Hall*			x														
86 Bellerophon plenus *Billings*			x														
87 B. *sp.*					x												
88 B. (Plectonotus ?) gaspensis			x														
89 Euphemus ? quebecensis					x												
90 Tropidocyclus brevilineatus (*Conrad*)					x		*	*									x
91 T. rotalinea (*Hall*)					x												x
Chitons																	
92 Probolaeum ? canadense	x																
Pelecypods																	
93 Actinopteria textilis (*Conrad*)	x		x									x	x				
94 A. communis *Hall*			x	x						x		x					*
95 A. fronsacia					x												
96 Aviculopecten ? incrassatus			x														

Tabular statement of the distribution in regions of eastern America, etc. (*continued*)

	St Alban beds	Capé Bon Ami beds	Grande Grève beds: Forillon	Grande Grève beds: Percé	Gaspé sandstone	Dalhousie beds	Chapman sandstone	Moose River sandstone	Helderbergian: Montreal	Helderbergian: New York	Helderbergian: Maryland	Oriskany: Eastern New York	Oriskany: Central New York	Oriskany: Decewville	Oriskany: Maryland	Onondaga limestone, including Schoharie grit	Hamilton beds (Skaneateles, Moscow and Ludlowville shales)
97 A. jumeaui				x													
98 A. *sp.*				x													
99 Pterinopecten proteus *Clarke mut.*			x			x											
100 Limoptera rosieri	x																
101 Megambonia crenistriata *Clarke*			x									x	*	*			
102 M. denysia				x													
103 Mytilarca canadensis *Billings*			x							*							
104 M. nitida *Billings*	x		x														
105 Cypricardinia distincta *Billings*			x													*	
106 C. planulata *Hall*	x													x		x	
107 Palaeopinna flabellum *Hall*	x		x		x			x					x				
108 Modiomorpha varia (*Billings*)	x	x	x														
109 Goniophora mediocris *Billings*	x		x														
110 G. tethys *Billings*			x														
111 G. *sp.*					x												
112 Grammysia canadensis *Billings*					x												x
113 Leptodomus canadensis (*Billings*)	x		x			*	*										
114 Modiella pygmaea (*Conrad*)					x												x
115 M. modiola					x												
116 Phthonia cylindrica *Hall*					x												x
117 Sphenotus truncatus (*Conrad*)					x												x
118 Schizodus ventricosus *Billings*			x							x							
119 S. appressus *Hall*					x												x
120 Nuculites triquetrus *Conrad*					x												x
121 N. *sp.*			x														
122 Palaeoneilo maxima (*Conrad*)					x												x
123 P. *cf.* constricta (*Conrad*)					x												x
124 Leda brevirostris *Hall*					x												x
125 Conocardium cuneus (*Conrad*)			x													x	
126 Lunulicardium ? convexum					x												
Brachiopods																	
127 Centronella glansfagea *Hall*			x											x		x	
128 Cryptonella ? fausta *Clarke*			x									x					
129 C ? ellsi			x														
130 C. *sp.*					x												
131 Rensselaeria ovoides gaspensis			x	x	x			x				x	x	x	x		

132 R. *sp.?*			x									*	*	*			
133 Megalanteris thunii			x	x											*		
134 Beachia amplexa			x	x													
135 Eatonia peculiaris (*Conrad*)			x		x					x	x	x	x	x	x		
136 Uncinulus vellicatus *Hall*	x									x							
137 U. mutabilis *Hall*			x							x							
138 Plethorhyncha barrandii *Hall*			x									x	x				
139 P. pliopleura (*Conrad*)			x						*			x	x				
140 Camarotoechia dryope (*Billings*)			x				x					*					
141 C. excellens (*Billings*)			x														
142 C. *cf.* ramsayi *Hall*			x										x		x		
143 C. semiplicata (*Conrad*)	x									x							
144 C. *cf.* altiplicata *Hall*	x									x							
145 Sieberella galeata (*Dalman*)	x									x	x						
146 Coelospira concava *Hall*			x							x	x						
147 Atrypina imbricata *Hall*	x									x							
148 A. *sp.*	x																
149 Atrypa reticularis *Linne*	x							x		x	x						
150 Leptocoelia flabellites (*Conrad*)			x	x	x			x			?	x	x	x	x		
151 Nucleospira ventricosa *Hall*	x		x							x							
152 Rhynchospira globosa *Hall*	x									x							
153 R. formosa *Hall*	x									x							
154 R. *sp.*			x														
155 Meristella laevis *Hall*	x	x								x							
156 M. lata *Hall*			x	x								x	x	x	x		
157 M. champlaini			x									*	*				
158 Athuris hera					x												
159 Cyrtina rostrata *Hall*			x	x							x	x	x	x	x		
160 C. hamiltonensis *Hall*					x												x
161 Spirifer perlamellosus *Hall*	x			x		x				x	x						
162 S. arenosus (*Conrad*)			x	x				x				x	x	x	x		
163 S. arenosus *var.* unicus *Hall*			x													x	
164 S. murchisoni Castelnau			x	x					x			x	x	x	x		
165 S. cyclopterus *Hall*			x					*		x	x						
166 S. plicatus (*Weller*)			x	x								?					
167 S. raricosta *Hall*			x													x	
168 S. fimbriatus (*Conrad*)			x									x	x			x	x
169 S. modestus *Hall var.* nitidulus			x							*	*						
170 S. gaspensis *Billings*					x												*
171 Leptaena rhomboidalis (*Wilckens*)	x	x	x	x		x	x		x	x	x	x	x	x	x		
172 Leptostrophia blainvillii (*Billings*)					x												*
173 L. magnifica *Hall*	x		x	*			*	x				x	x	x	x		
174 L. magnifica *var.* tullia *Billings*				x								*	*	*	*		
175 L. irene (*Billings*)			x									*	*				
176 L. oriskania *Clarke*			x					x				x					
177 L. tardifi				x													
178 L. becki *Hall*	x									x	x						
179 Strophonella continens			x														
180 S. continens *var.* equiplicata			x														
181 S. continens *var.* senilis			x														
182 S. continens *var.* equalis			x														

Tabular statement of the distribution in regions of eastern America, etc. (*concluded*)

	St Alban beds	Capé Bon Ami beds	Grande Grève beds: Forillon	Grande Grève beds: Percé	Gaspé sandstone	Dalhousie beds	Chapman sandstone	Moose River sandstone	Helderbergian: Montreal	Helderbergian: New York	Helderbergian: Maryland	Oriskany: Eastern New York	Oriskany: Central New York	Oriskany: Decewville	Oriskany: Maryland	Onondaga limestone, including Schoharie grit	Hamilton beds (Skaneateles, Moscow and Ludlowville shales)
183 S. ampla *Hall*			x													x	
184 S. punctulifera (*Conrad*)	x					x			x	x							
185 S. leavenworthana *Hall*	x									x							
186 Brachyprion majus *Clarke*			x			x						x					
187 Stropheodonta rosieri	x									*							
188 S. pattersoni *Hall* precedens	x		x													*	
189 S. parva *Hall* avita			x													*	
190 S. crebristriata *Hall* simplex			x													*	
191 S. galatea (*Billings*)			x														
192 S. hunti			x														
193 S. lincklaeni *Hall*			x	x								x	x				
194 S. magniventer *Hall*			x				x					x	x		x		
195 Orthothetes woolworthanus *Hall*	x		*					x		x	x						
196 O. woolworthanus *mut.* gaspensis	*		x							*							
197 O. becraftensis *Clarke*			x		x							x					
198 Gaspesia aurelia (*Billings*)			x														
199 Hipparionyx proximus *Vanuxem*			x	x				x				x	x	x	x		
200 Orthostrophia canadensis	x									*							
201 Schizophoria ? amii			x														
202 Rhipidomella logani			x													*	
203 R. musculosa *Hall*			x					*	?			x	x	x	x		
204 R. lehuquetiana			x														
205 R. *sp.*			x														
206 Dalmanella subcarinata *Hall*	x									::							
207 D. *cf.* discus *Hall*	x									x		x					
208 D. lucia (*Billings*)			x														
209 D. penouili					x												
210 Chonostrophia dawsoni (*Billings*)			*	*	x			x	*	*		*					
211 C. complanata *Hall*			x	x	*					*		x	x	x	x		
212 Chonetes canadensis *Billings*			x	x				x									
213 C. melonicus *Billings*			x														
214 C. antiopa *Billings*			x	x													
215 C. billingsi			x		x												
216 C. hudsonicus *Clarke* gaspensis					x			x				x					
217 Anoplia nucleata *Hall*			x				x					x	x	x	x		
218 Crania pulchella *H. & C*			x							x		x					

219 Craniella ? grandegrevensis			x	x						*							
220 Pholidops ovatus *Hall*	x		x	x		x				x							
221 P. terminalis *Hall*			x	x				x				x	x		x		
222 Orbiculoidea montis			x	x								*	*				
223 O. belia (*Billings*)	x																
224 O.			x														
225 Lingula rectilatera *Hall*			x	x						x							
226 L. artemis *Billings*		x															
227 L. spathata *Hall*				x						x							
228 L. lucretia *Billings*		x															
229 L. elliptica			x	x													
230 Glossina acer			x														
Bryozoans																	
231 Fenestella *cf.* lata *Hall*			x													x	
232 Polypora ? psyche *Billings*			x														
233 Stictopora			x														
234 Hederella blainvillii					x												*
Corals																	
235 Duncanella *cf.* rudis *Girty*		x								x							
236 Zaphrentis incondita *Billings*			x														
237 Z. corticata *Billings*				x													
238 Z. cingulosa *Billings*				x													
239 Z. shumardi *M.-E. & H.*	x					x											
240 Phillipsastrea verneuili *Billings*			x														
241 Favosites helderbergiae *Hall*			x			x				x							
242 F. *cf.* gaspensis *Lambe*	x																
243 Pleurodictyum lenticulare *Hall var.* laurentinum				x						x							
244 Monticulipora *sp.*				x													
245 Striatopora *cf.* issa *Hall*				x						x							
Graptolites																	
246 Dictyonema splendens *Billings*	x		x			x											
247 Chaunograptus gracilis			x														
Sponges																	
248 Receptaculites jonesi *Billings*			x														
249 Hexactinellida			x							*							
250 Hindia fibrosa (*Roemer*)	x	x					x			x							
Plants																	
251 Alga	x																
252 Spirophyton *cf.* cauda-galli *Vanuxem*	x															x	
	51–1	11	146 (148 ?)–4	50–3	47–1	15–3	7–6	15–4	1–1	43–13	11(12?)–2	12 (13 ?)–11	24–8	15–7	18–6	13–8	15–7

Summary. On earlier pages we have indicated the relations of these Gaspé faunas to each other and to those of other regions. These may be briefly restated:

The St Alban beds present a congeries of 51 species of which fully one half occurs in the typical Helderbergian faunas (Coeymans and New Scotland) to the southwest. This very large community of species is evidence of an open and free passage between the Gaspé basin and the New York embayment of the Mississippian sea (Appalachian gulf). On a later occasion we shall have means of pointing out in detail a very like community of species in the Dalhousie beds of New Brunswick and the Helderberg of New York, but singularly, in the two cases, this agreement is based on quite distinctive associations of species. There is not much in common between the St Alban and the Dalhousie faunas, but between each of these and the Helderberg fauna there is harmony in certain faunal associations suggesting that the open channel of this date southwestward included the Dalhousie region also; that intimate commingling of the peculiar Dalhousie and St Alban associations was prevented by a barrier of some kind and, further, that dispersion was from the breeding ground of Gaspé, southwestward, to where the several associations combined into one.

The more profuse fauna of the Grande Grève limestones, rising to about 150 recorded species, has a less proportion of community with the Helderbergian but still a substantial number of species (21 identities and 14 close affines). With the Oriskany there is a larger community of species (39 identities and 13 affines) and so commanding is this percentage and the composition of the congeries itself, consisting as it does of the most typical species of the Oriskany, that it compels this inference: The development of this Oriskany fauna was synchronous with the prevalence of the Helderbergian fauna in this region and the differentiation of the two faunal elements which we commonly recognize in the Appalachian regions as Helderberg and Oriskany, was subsequent in date to the development of the combined faunas together in Gaspé. Thus again we have evidence that the

Gaspé basin was a center of dispersion of these two faunas and that the direction of this dispersion so far as the facts now indicate was still toward the southwest.

The Gaspé sandstone presents a very different condition. In this fauna of about 50 species so far as registered, one seventh to one sixth are survivors of the Oriskany element in the Grande Grève limestones. With the Hamilton faunas from the calcareous shales of the Skaneateles, Moscow and Ludlowville formations of New York, this Gaspé sandstone fauna presents a predominant agreement, having 16 identities and 6 affines, or approaching fifty per cent of the fauna. This very interesting condition seems to indicate an invasion of the later fauna from the west, while the earlier Oriskany-Helderberg fauna was still occupying the ground. The interval represented in the Appalachian gulf by the deposition of the Schoharie grit and Onondaga limestone and other closely allied faunas is not differentiated in Gaspé but there is a positive forecast of this fauna among the Grande Grève fossils. Thus there are here 13 identities and 12 faunas with Onondaga species. The Onondaga fauna therefore is here one of the undifferentiated elements of the autochthonous Grande Grève fauna. Several of its members bear distinctive marks of primitive structural condition to be perfected only in the later stage of differentiation when the fully matured Onondaga fauna held its place in the orderly and refined succession in the New York field.

The evidence is thus fairly cumulative that the Gaspé basin was an area of rapid evolution during the early Devonic and a center of dispersion from which the lines of immigration departed westward. We can not now say that they did not also lead thence eastward. In a later Devonic stage this basin was the recipient of migrants from the west. The course of migration into and out of the interior Appalachian waters was along a seaway which can not yet be traced step by step, but evidently parallel to the Appalachian folds. There seems now a fair presumption of a continuous connection between the Gaspé basin and the east by way of the Connecticut

trough into eastern New York. The tangible evidence for this connection will be set forth more fully hereafter. The Gaspé Eodevonic basin extended from the Canadian Archean shield at the north to the limit of the Dalhousie beds on the south and contracted in the middle Devonic. Apparently there was no free and open conection between it and the parallel contemporaneous embayments at the south in which the Chapman and Moose river sandstones of Maine were set down.

View of Percé Rock, from the south; Mt Joli and Cape Canon at the left

EXPLANATION OF PLATES

This work has been long on the press on account of the difficulties attending the execution of the lithographic plates. The differences apparent in the quality and tint of the papers used have, in the face of these obstacles, been unavoidable. The lithographic drawing, however, has been executed by the best artists obtainable and is wholly satisfactory.

PLATE 1

Lichas (Gaspelichas) forillonia nov.

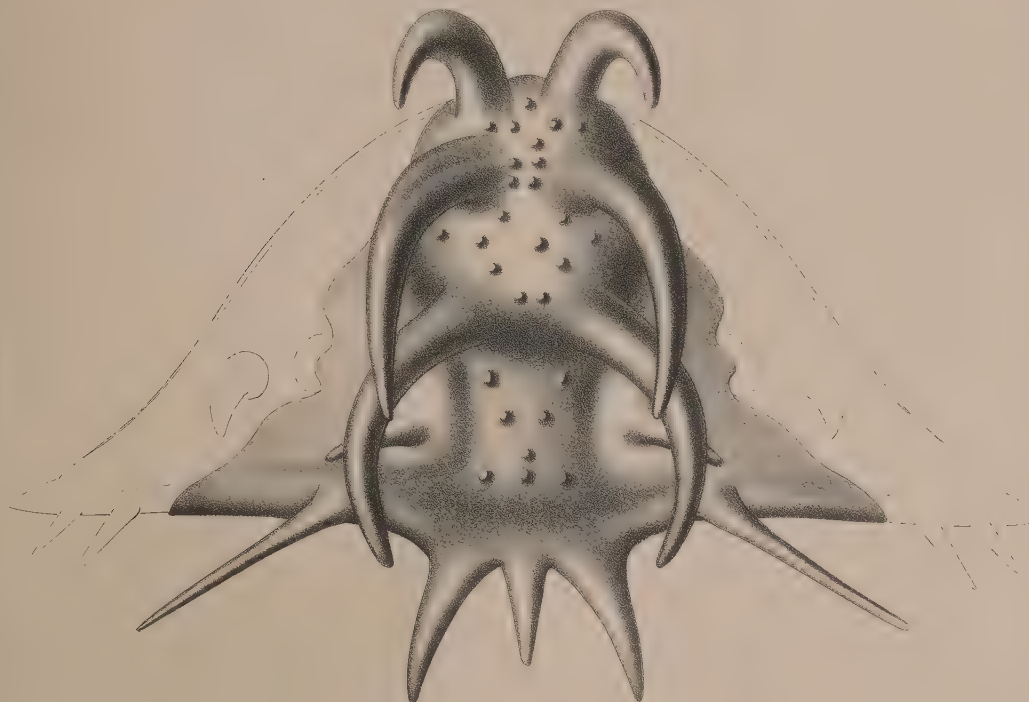
(*See* plates 2, 3)

Page 137

1, 2 Two views of a large cranidium with outline restoration in figure 1 of the details of the free cheeks; showing the three pairs of heavy curved spines on the glabella, the single shorter pair on the lateral lobes, the median and broad stout curved pair on the occipital ring with a single long and slender pair at the sides

Grande Grève limestone. Extracted from the compact dolomites of the Forillon on Dolbel brook at the base of the series and partially restored

1



2

G. S. Barkentin del. B. Meisel lith.

PLATE 2

Lichas (Gaspelichas) forillonia nov.

(*See* plates 1, 3)

Page 137

2 Two views of a smaller cranidium

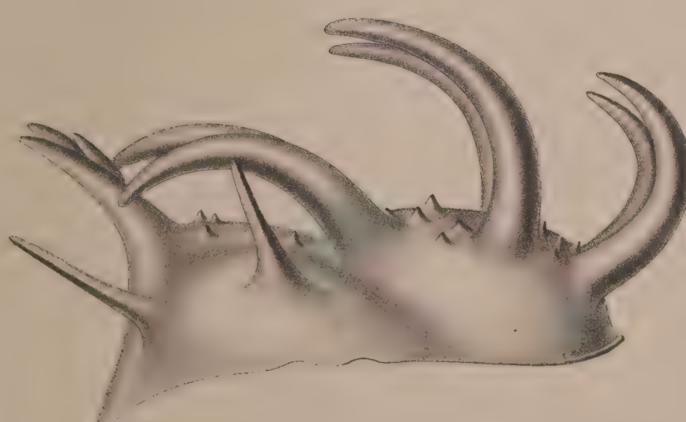
Grande Grève limestone; from the weathered cherty beds of the second or middle division. Grande Grève

3 Side view of the specimen shown on plate 1

1

2

3



G. S. Barkentin del. B. Meisel lith

PLATE 3

Lichas (Gaspelichas) forillonia nov.

(*See* plates 1, 2)

Page 137

1 A specimen of the cranidium embedded in the rock and so far as exposed showing but two pairs of glabellar spines
Grande Grève limestone; division 1. Dolbel brook

2 A portion of the free cheek, doubtfully referred to this species
Grande Grève limestone; division 2. Grande Grève

3, 4 Views of what is regarded as a free cheek, figure 3 showing the genal spine extended, figure 4 that spine foreshortened and the spine just outside and below the eye in its erect posture

Lichas bellamicus nov.

Page 137

5 An hypostoma referred to this species
Grande Grève limestone; division 2. Indian Cove

6 Cranidium. x 1½

7 An incomplete pygidium

8 Portion of a spinose cranidium, possibly representing this species
Grande Grève limestone; division 2. Grande Grève

Ceratocephala robinia nov.

Page 140

9, 10 Two cranidia. x 3
Grande Grève limestone. Dolbel brook and Grande Grève

11 An incomplete individual. From a specimen in the Redpath Museum, McGill University
Grande Grève limestone; division 2. Grande Grève

Memoir 9. N.Y. State Museum. Plate 3.

G. S. Barkentin del. B. Meisel lith

PLATE 4

Dalmanites perceensis nov.

(*See* plate 5)

Page 126

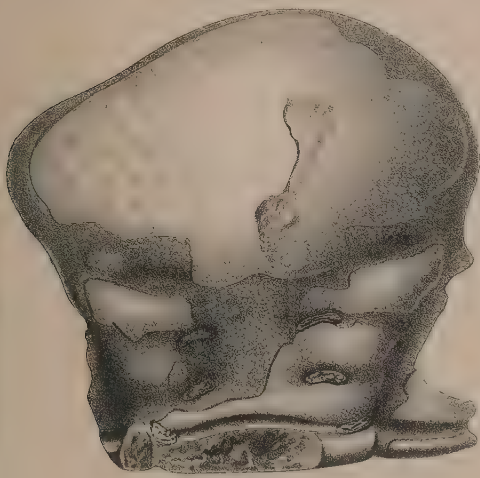
1, 2 Incomplete cranidia of large individuals

3 A large, incomplete pygidium, showing the degree of segmentation and the sparsely nodose ribs

Grande Grève limestone. Percé Rock

TRILOBITES

1



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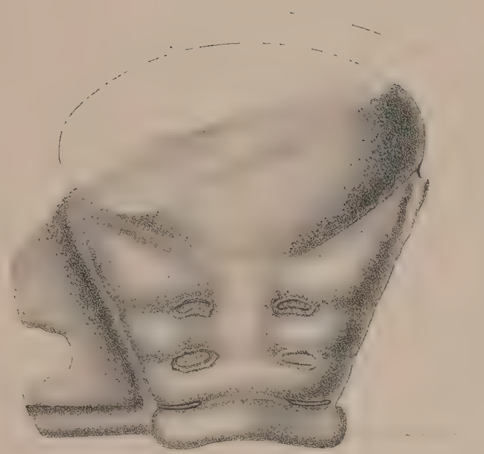

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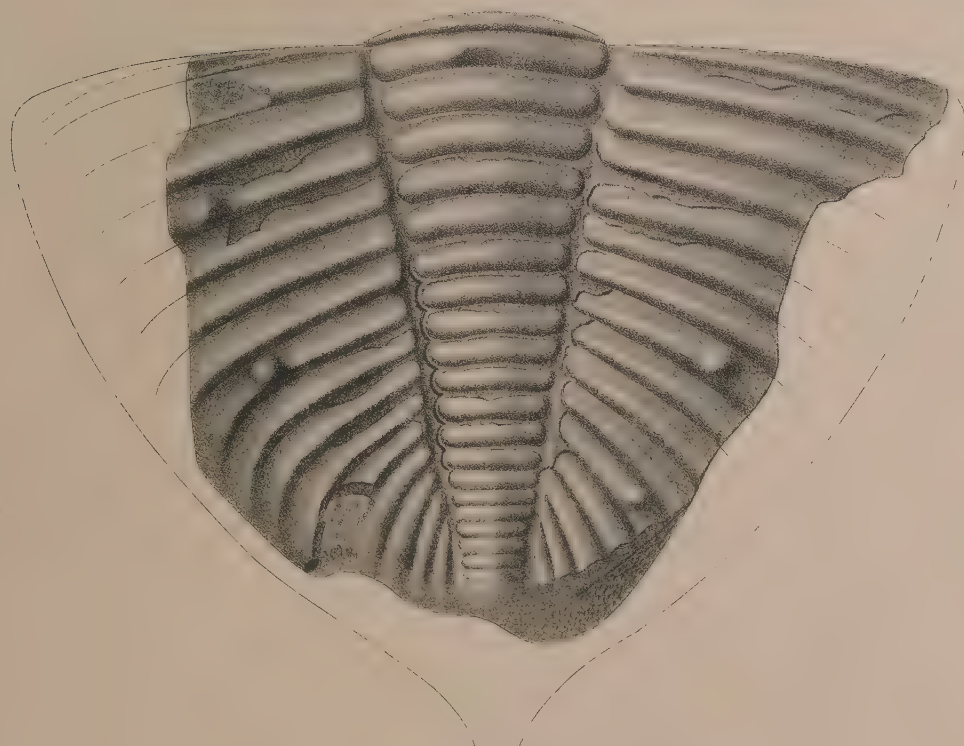


G. S. Barkentin del.

B. Meisel lith.

PLATE 5

Dalmanites (Probolium) tridens Hall

Page 129

1 An entire and undistorted cephalon with shovel-shaped, slightly trifid snout

New Scotland beds. Clarksville, N. Y.

Collected by the late Prof. C. E. Beecher, 1887, (while a member of the State Museum staff) and now in the Yale University Museum

Dalmanites perceensis nov.

(*See* plate 4)

Page 126

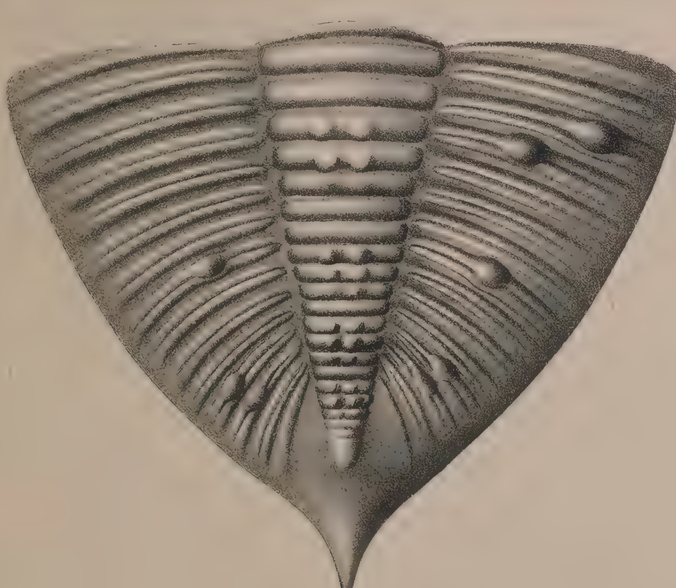
2 An entire pygidium with clearly defined sulcate ribs, coarse and irregularly scattered nodes on the sides and regularly paired nodes along the axis

Grande Grève limestone. Percé Rock

TRILOBITES

1

2



G. S. Barkentin del. B. Meisel lith.

PLATE 6

Dalmanites (Probolium) biardi nov.

Page 129

1 A small head showing the general proportions and the marginal undulations, the snout being lost

2 Portion of a smaller head with surface markings. x 3

3 Cast of doublure showing the trifid snout with projections on the sides

4 An enlargement of the snout. x 2

5–7, 9, 10 Pygidia showing the character of the ribs, duplicate on the exterior, simple on the cast, and the form and size of the tail spine

8 A rather large cephalon, mostly excoriated and with the central branch of the snout broken off

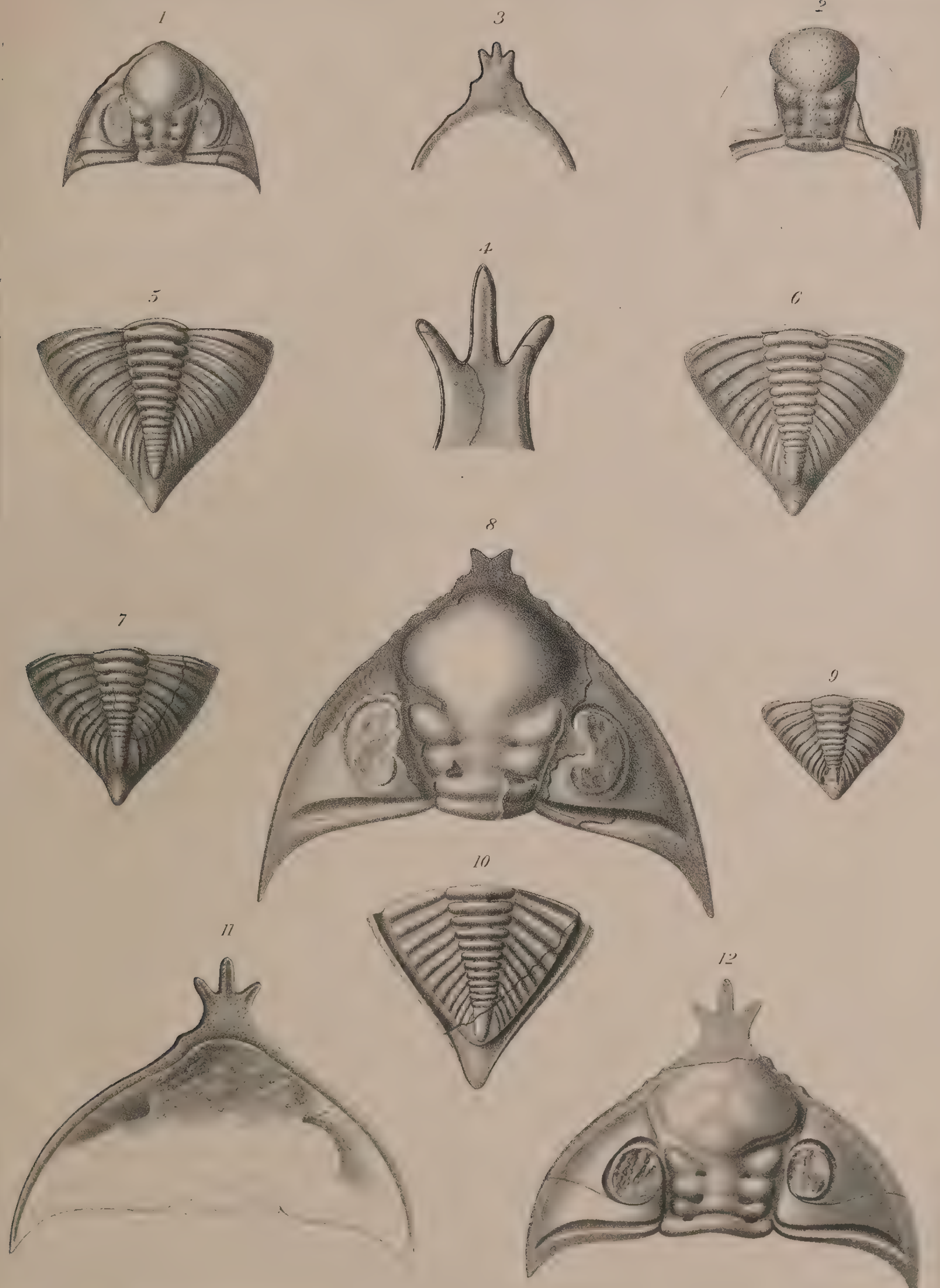
11 The cephalic doublure

12 A cephalon retaining the snout and showing the marginal crenulations

Grande Grève limestone. Percé Rock

TRILOBITES

Memoir 9. N. Y. State Museum. Plate



G. S. Barkentin del. B. Meisel lith

PLATE 7

Dalmanites coxius nov.

Page 103

1 The original specimen, a pygidium with flat ribs which on the pleurae are very finely sulcate

St Alban beds. "Between Cape Gaspé and Cape Rosier." (National Museum)

Dalmanites emarginatus Hall

Page 127

2 Part of one pygidial pleura, showing the style of ornament. x 2

3 An entire pygidium showing the reëntrant curve at the caudal extremity

Grande Grève limestone; cherty beds of division 2. Grande Grève to Little Gaspé

Dalmanites griffoni nov.

(*See* plate 9, figure 4)

Page 103

4 A pygidium showing ornament and segmentation. x 2

St Alban beds. Grande Cavée of Griffon Cove river

Dalmanites phacoptyx Hall & Clarke

Page 123

5 Part of a pygidium

6 A portion of a cephalon retaining the eye and showing the character of the surface

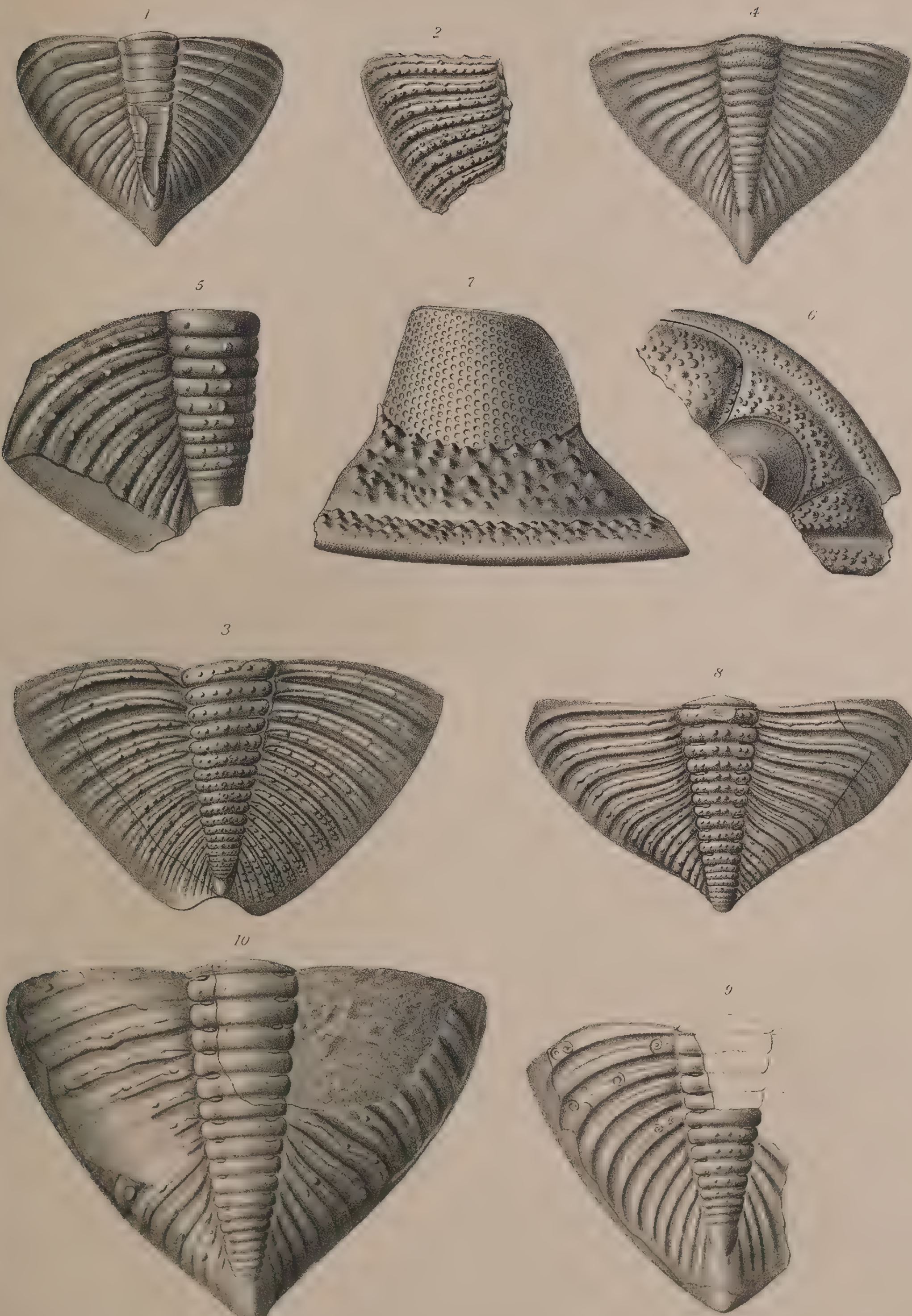
7 The visual surface of the same in normally erect profile. x 2

8 A pygidium somewhat distorted by axial compression

9 Incomplete internal cast of the pygidium with Spirorbis latissimus attached

10 An entire, somewhat worn pygidium

Grande Grève limestone; divisions 2 and 3. Vicinity of Grande Grève



G. S Barkentin del.

B Meisel lith

PLATE 8

Dalmanites dolbeli nov.

Page 121

1 Internal cast of a normal cephalon, short, with short genal angles and crenulated frontal margin

2 Internal cast of a less complete specimen

3 Thorax and pygidium

4 Internal cast of the cephalon

5 External surface of the glabella and eyes showing the actual coalescence of the first and second lobes on the exterior (Synphoria condition) in contrast to the strongly lobed internal cast

6, 7 Pygidia of the species, figure 7 preserving the crust and showing the fine lineate sulcus on the pleural ribs

Grande Grève limestone; division 2. Outcrops about Grande Grève, Indian Cove and Shiphead

Dalmanites gaveyi nov.

Page 128

8 A cephalon showing the slight frontal projection, the lobation of the glabella and short genal angles

9 Cephalon with portion of the thorax

Grande Grève limestone; division 2. Near Grande Grève

Dalmanites micrurus ?

Page 120

10, 12 Pygidia referred with hesitation to this species and possibly pertaining to the cephalon represented on the following plate [fig. 1, 3]

Grande Grève limestone; division 2. Lehuquet's Cove, Grande Grève

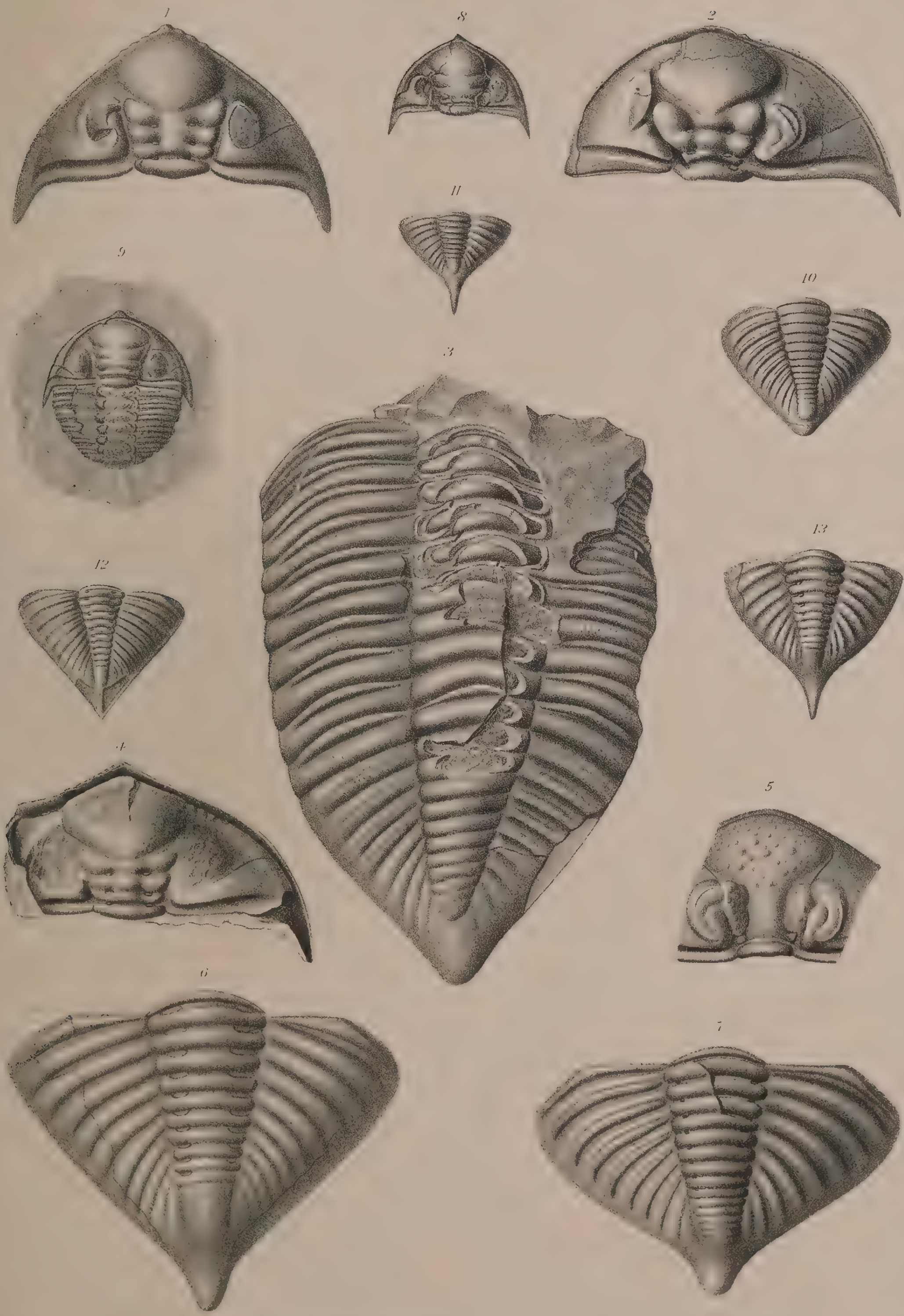
Dalmanites whiteavesi nov.

Page 125

11, 13 Pygidia with slender terete caudal spines

Grande Grève limestone; division 2. Grande Grève

TRILOBITES



G. S. Barkentin del.

B. Meise lith

PLATE 9

Dalmanites micrurus (Green)

(*See* plate 8)

Page 120

1, 3 Two more or less complete cephala showing the character of the surface and the smooth flat border

Grande Grève limestone; division 2. Lehuquet's Cove, Grande Grève

2 An entire cephalon of a typical specimen from the original locality

Coeymans limestone. Schoharie, N. Y.

Dalmanites griffoni nov.

(*See* plate 7)

Page 103

4 A cephalon with the frontal process restored in accordance with the outline as indicated in the matrix

St Alban beds. Grande Cavée of Griffon Cove river

Dalmanites (Probolium) esnoufi nov.

Page 130

5 Cephalon with bifurcate snout

Grande Grève limestone; division 2. Grande Grève

Dalmanites lowi nov.

Page 122

6 An imperfect pygidium

7 Enlargement x 2 of a portion of the pleura showing the strongly sulcate ribs

8 A pygidium essentially complete

Grande Grève limestone; division 2. Grande Grève and vicinity

Cordania gasepiou nov.

Page 136

9 The cranidium. x 2

10 An entire individual. x 3

Grande Grève limestone; division 2. Lehuquet's Cove

TRILOBITES

G. S. Barkentin del. B. Meisel lith.

Cordania becraftensis Clarke

Page 136

11 The greater part of the cranidium. x 2
Grande Grève limestone; division 2. Grande Grève

Bronteus barrandii Hall

Page 104

12, 13 A pygidium, natural size (12) and x 3 (13)
St Alban beds. Cape Rosier Cove

Proetus phocion Billings

Page 135

14 The original specimen

15 An enrolled specimen from the Museum of the Geological Survey of Canada, previously figured in *Palaeontology of New York*, v. 7, pl. 25, fig. 10

16 A large pygidium
Grande Grève limestone; division 2. Vicinity of Grande Grève

Bythocypris nov.

Page 141

17–19 A worn left valve and two right valves retaining the sculpture. x 10
Grande Grève limestone; division 2. Grande Grève

PLATE 10

Phacops logani (Hall) Clarke

Page 118

1-4 Small cephala with spinules at the genal angles

7, 8 Pygidia enlarged; 7, x 2; 8, x 3

9 An enrolled individual viewed in profile. x 2

Grande Grève limestone. Percé Rock

Phacops logani Hall var. **gaspensis** nov.

Page 119

5 A small pygidium. x 2

6 A large pygidium

10 A group of individuals preserved as internal casts on chert and showing the rows of tubercles along the dorsal furrows

11–13 Three views of a large coarsely tubercled cephalon having the character of Phacops bombifrons Hall

14, 15 Two views of a similar specimen

Grande Grève limestone. Various outcrops along the Forillon

16 Thorax and pygidium

St Alban beds. Grande Cavée of Griffon Cove river

Phacops (Phacopidella) correlator Clarke

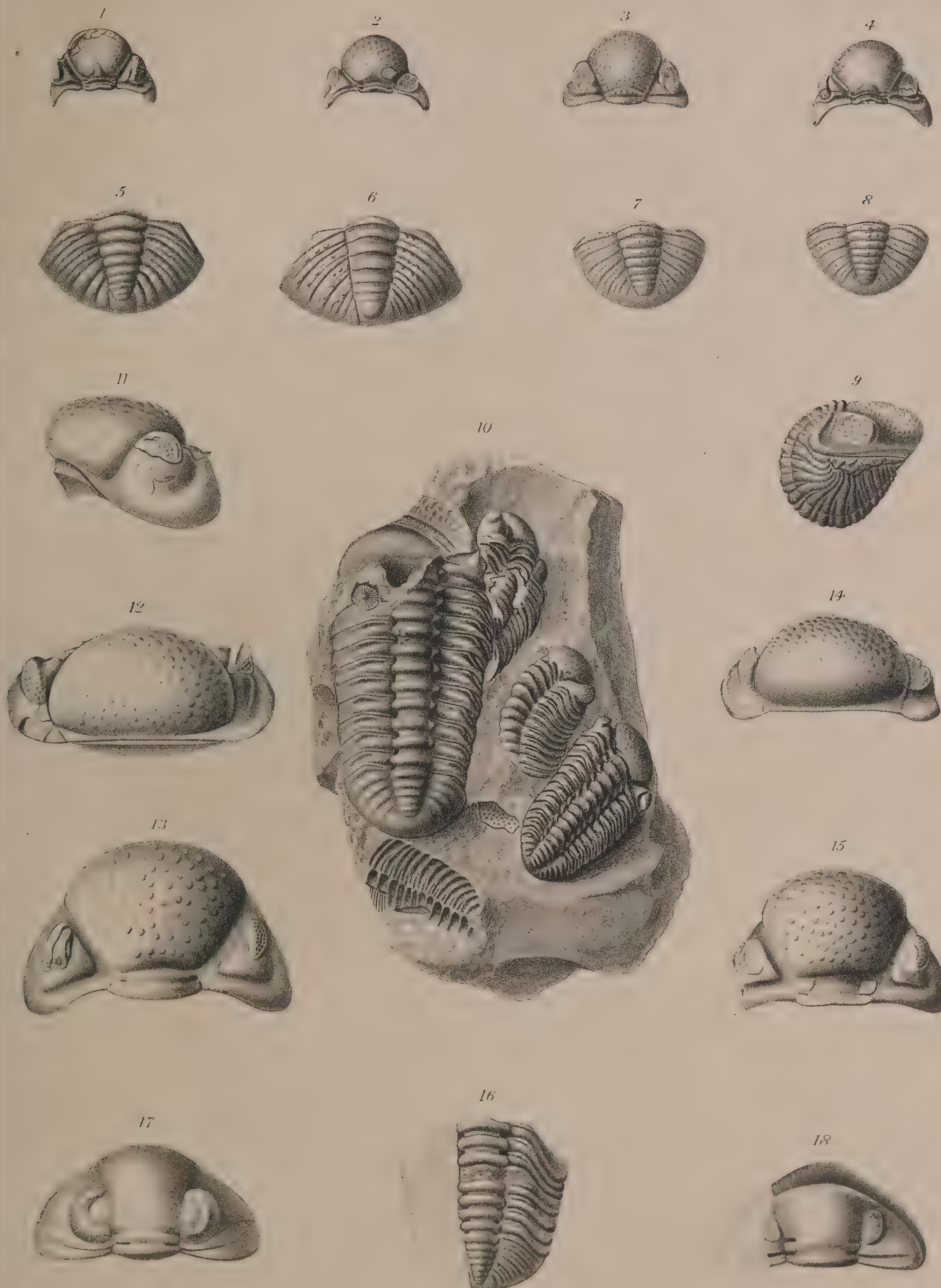
Page 226

17 Exterior of an entire cephalon. x 3

18 Internal cast of a cephalon with the margin cut away to show doublure. x 3

Gaspé sandstone. Gaspé Basin

TRILOBITES



G. S. Barkentin del B. Meisel lith

PLATE 11

Autodetus beecheri Clarke

Page 117

1, 2 Views of two internal casts. x 4
Grande Grève limestone; division 2. Grande Grève

Spirorbis latissimus nov.

Page 117

3, 4 Two individuals attached to Kionoceras rhysum. x 10
Grande Grève limestone; division 2. Grande Grève

Cornulites cingulatus Hall

Page 117

5 An internal cast. x 3
Grande Grève limestone; division 2. Grande Grève

Conularia lata Hall mut.

Page 144

6 The tip of a specimen showing septum and the callus which may result from fixation. x 2
7 The surface. x 10
8 A large specimen, one of a cluster
9 Two small individuals from a group of several
Grande Grève limestone. Figure 6 from Grande Grève, figure 9 between Grande Grève and Little Gaspé, beds of division 2. Figures 7, 8 from Little Gaspé, division 3

Conularia penouili nov.

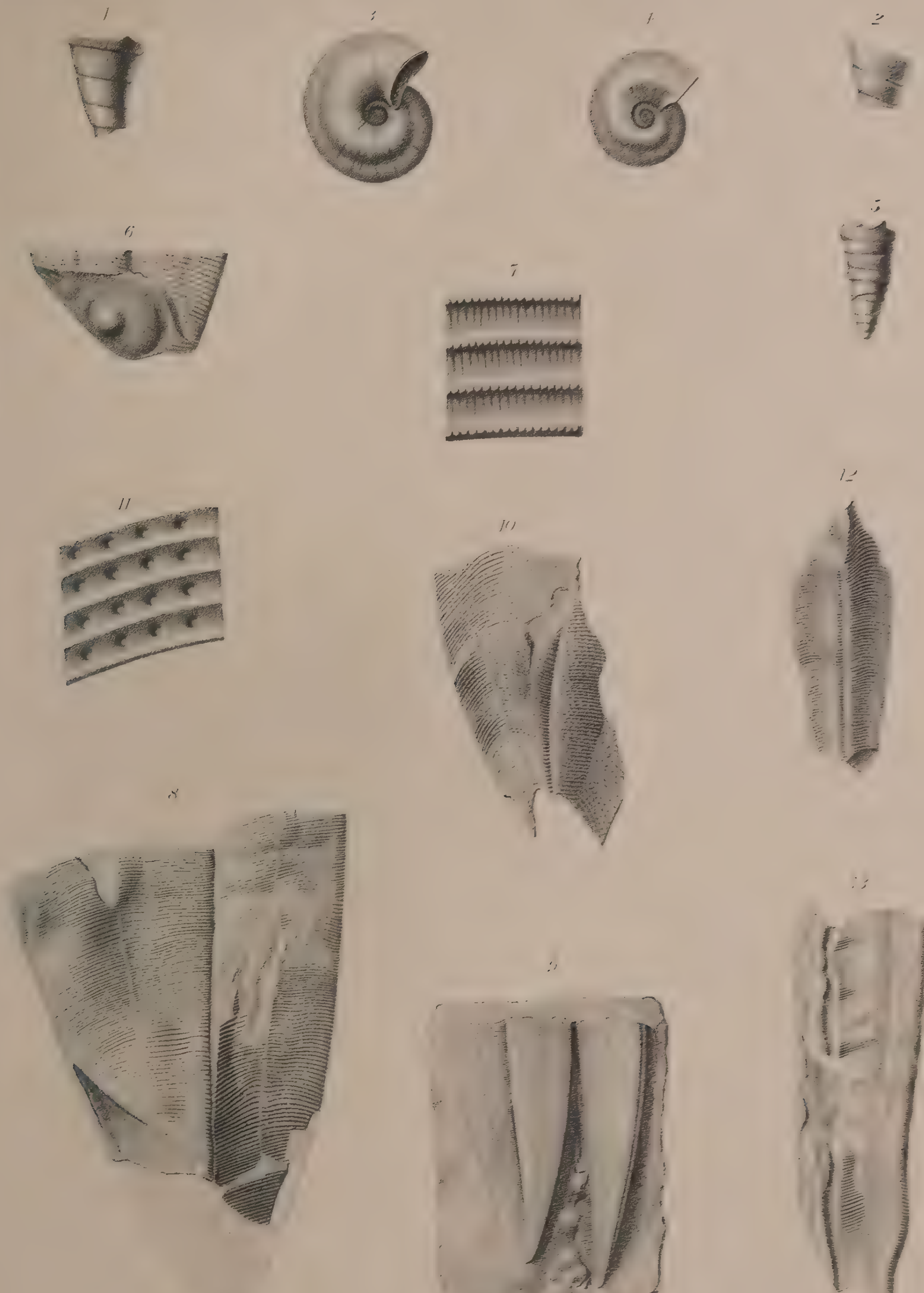
Page 144

10 A somewhat incomplete specimen
11 The surface of the same enlarged
Grande Grève limestone. Loose in brook at Peninsula

Conularia cf. **desiderata** Hall

Page 144

12 A fragment having the characters of this species
Grande Grève limestone; division 2. Grande Grève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Conularia desiderata var. **tuzoi** nov.

Page 144

13 An elongate, slender individual
Grande Grève limestone. Percé Rock
275

PLATE 12

Tentaculites cartieri nov.

Page 226

1–3 Three specimens enlarged, 1 and 3, x 2; 2, x 4

4 An internal cast of a small individual. x 3

Gaspé sandstone. Gaspé Basin

Tentaculites leclerqius nov.

(*cf.* T. gyracanthus Eaton)

Page 117

5 A group of individuals, some of them exfoliated. x 2

6 A portion enlarged to show the difference in size of the annulations. x 5

7 A rather regularly annulated example. x 5

Grande Grève limestone. Percé Rock

Tentaculites elongatus Hall

Page 118

8 A compressed example. x 2

9 Enlargement of the surface. x 10

Grande Grève limestone; division 2. Grande Grève

Hyolithus oxys nov.

Page 143

10 Dorsal view of specimen. x 1½

11–13 Three views of the one example. x 1½

Grande Grève limestone; division 2. Grande Gréve

Hyolithus richardi nov.

Page 143

14–17 Views of silica replacements showing the differences in sculpture on the two sides and the form of the transverse section

Grande Grève limestone; division 2. Grande Grève

Hyolithus cf. **aclis** Hall

Page 226

18 Ventral side of a specimen. x 3

Gaspé sandstone. Gaspé Basin.

ANNELIDS

G. S. Barkentin del

B. Meisel lith

PLATE 13

Kionoceras rhysum nov.

Page 142

1, 2 Parts of small individuals

3 A fragment bearing detached individuals of Spirorbis latissimus [*see* pl. 11, fig. 3, 4]

4, 5 Fragments of large individuals of the same annulated type and believed to belong to this species

Grande Grève limestone; division 2. Grande Grève

Cyrtoceras albani nov.

Page 105

6 A specimen showing the curvature and expansion of the shell near the aperture

7 A fragment retaining the external markings

St Alban beds. Cape Rosier Cove

Kionoceras champlaini nov.

Page 142

8 A longicone with equidistant elevated longitudinal ribs and low annulations

Grande Grève beds; division 2. Grande Grève

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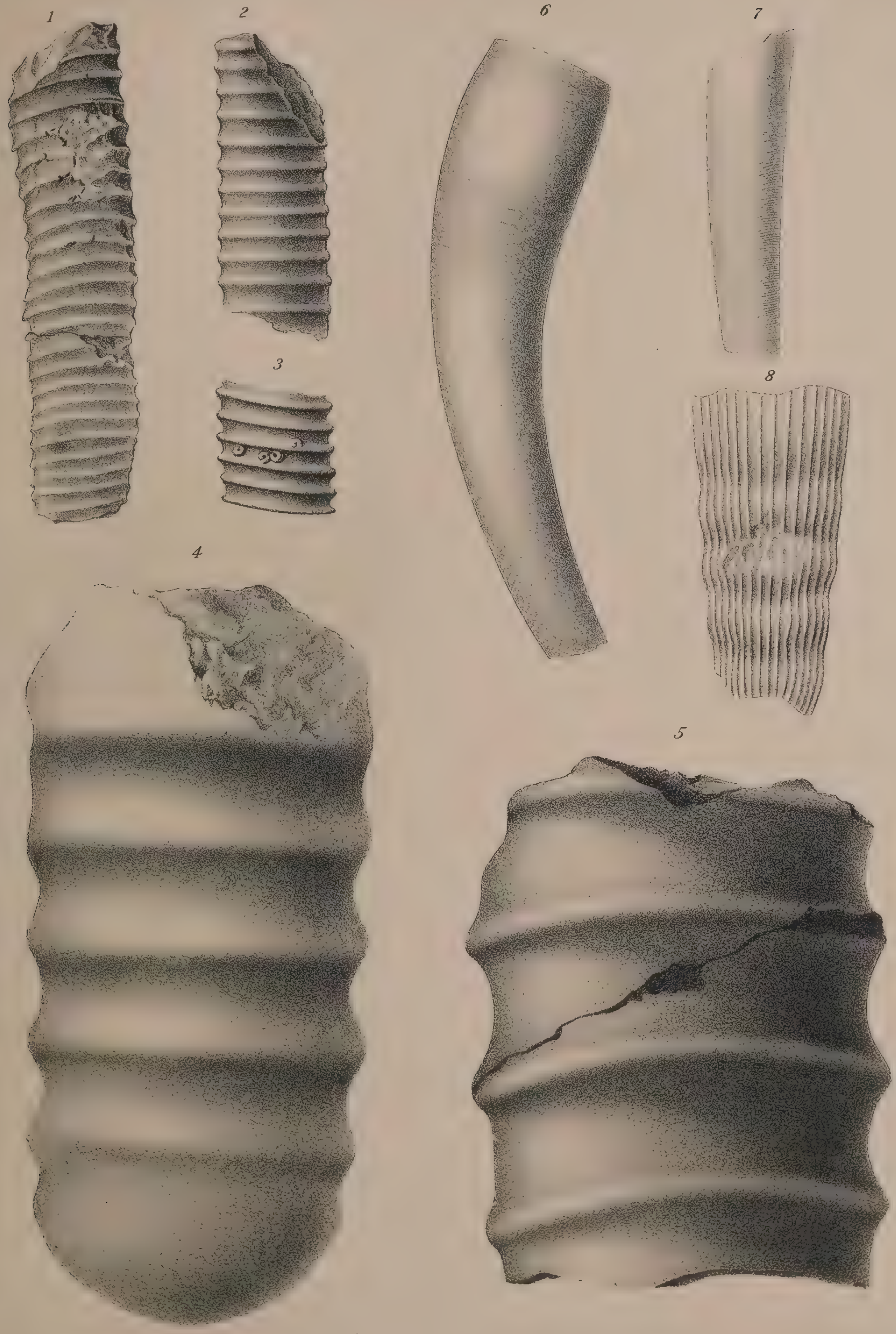


S Barker

PLATE 14

Platyceras leboutillieri nov.

Page 145

1, 2 Two views of the same specimen
Grande Grève limestone. Percé Rock

3, 4 A silica replacement
Grande Grève limestone; division 2. Grande Grève

Platyceras sp.

Page 148

5, 6 Dorsal and side views
Grande Grève limestone; division 2. Grande Grève

Platyceras sp.

Page 148

7, 16 *Grande Grève limestone.* Percé Rock

Platyceras cf. **fornicatum** Hall

Page 145

8, 9 Dorsal and side views
Grande Grève limestone; division 2. Grande Grève

Platyceras cf. **nodosum** Conrad

Page 146

10, 11 Side and dorsal views
Grande Grève limestone; division 2. Grande Grève

Platyceras lejeunii nov.

Page 147

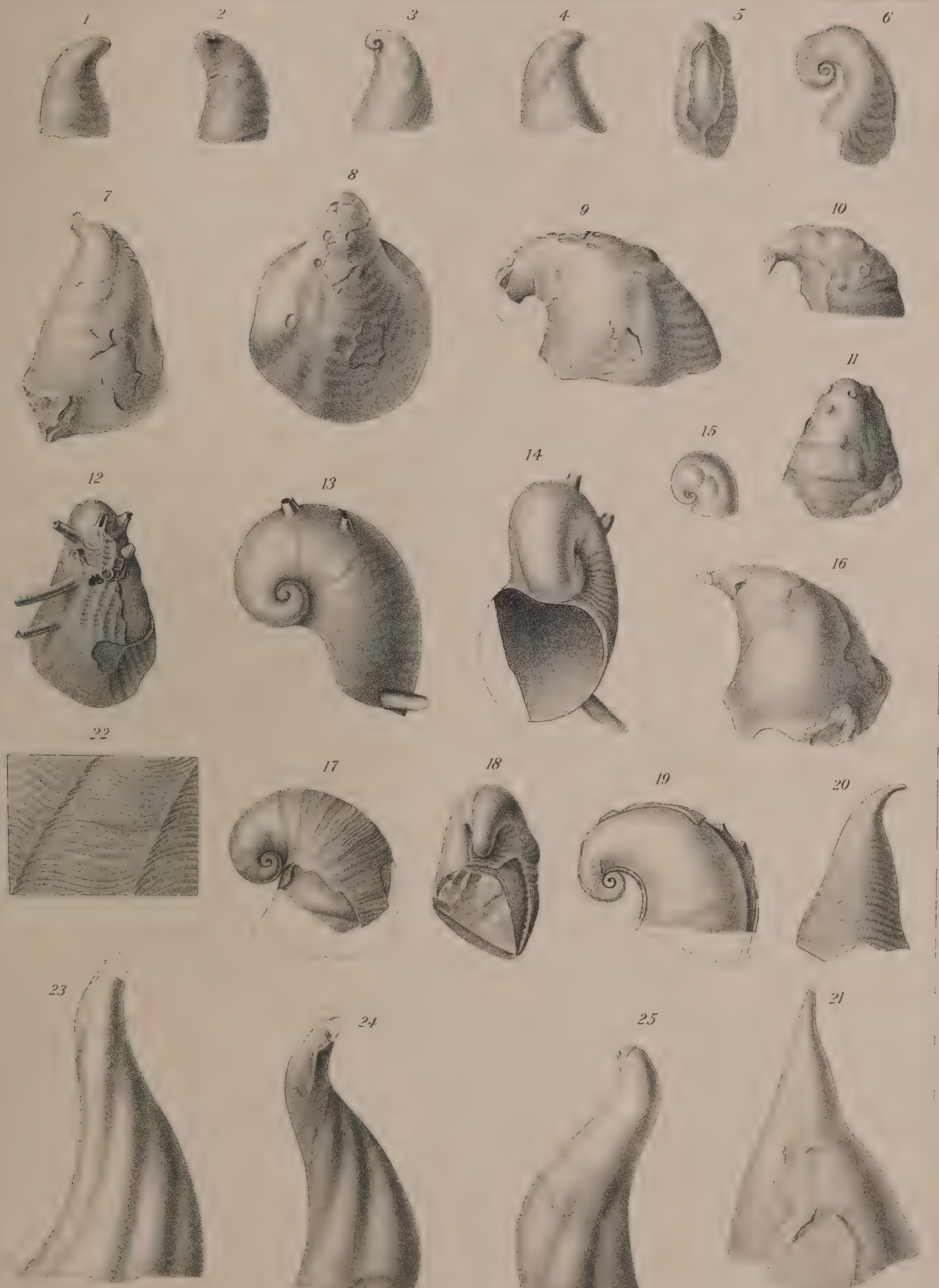
12 Dorsal view showing the spines and sculpture of the surface. x 1½
Grande Grève limestone; division 2. Grande Grève

Platyceras paxillifer nov.

Page 146

13, 14 Two views showing the smooth sparsely spinose surface. x 3
Grande Grève limestone; division 2. Grande Grève

GASTROPODS



G. S. Barkentin del.

B. Meisel lith.

Platyceras gaspense nov.

Page 227

15 Side view, natural size

Gaspé sandstone. Gaspé Basin

Platyceras guesnini nov.

Page 147

17, 18 Side and ventral views

19 Side of a largely exfoliated specimen

Grande Grève limestone. Percè Rock

Platyceras (**Orthonychia**) **belli** nov.

Page 147

20 Small silica replacement. x 2

21 A larger compressed example

Grande Grève limestone; division 2. Grande Grève

Platyceras tortuosum Hall

Page 146

22 Enlargement of sculpture

23–25 Two specimens of average size

Grande Grève limestone. Percé Rock

PLATE 15

Holopea gaspesia nov.

Page 227

1–7 A series illustrating this variable shell; 1 (x 2), showing the normal contour and usual style of surface; 2 (x 3), 3 and 5 (x 2), compressed shells with coarser or fasciculated striae near the sutures; 4 and 7 (x 2), specimens with evidences of a peripheral band too strongly indicated in the drawings and probably not of the nature of a slit band; 6 (x 3), a shell in which the finer concentric lines are lost

Gaspé sandstone. Gaspé Basin

Callonema cf. **bellatulum** Hall

Page 228

8 A specimen with depressed subangulate whorls and coarse concentric sculpture. x 2

Gaspé sandstone. Gaspé Basin

Holopea wakehami nov.

Page 228

9, 10 Two specimens showing the smooth exterior and low short spiral. x 3

11 Front view of a somewhat more elongate shell. x 3

Gaspé sandstone. Gaspé Basin

Holopea cf. **antiqua** Vanuxem

Page 148

12–14 Characteristic examples of this shell. x 2

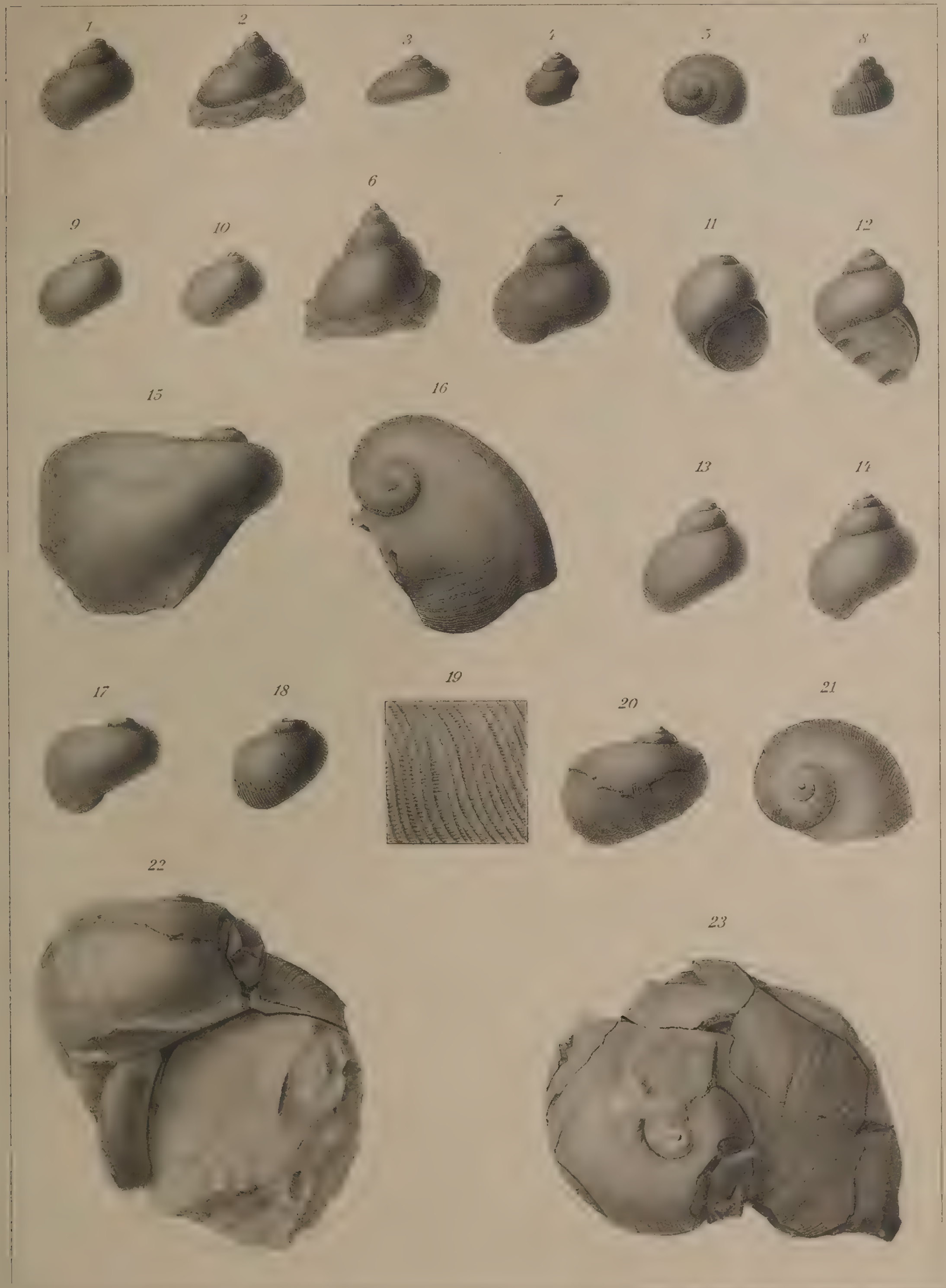
Grande Grève limestone; division 2. Lehuquet's Cove

Strophostylus expansus Hall

Page 150

15, 16 Two views of the same specimen

Grande Grève limestone; division 2. Grande Grève



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Diaphorostoma desmatum Clarke

Page 149

17 An internal cast

19 The sculpture. x 5

20, 21 An individual showing the surface characters

Grande Grève limestone; divisions 1 and 2. Grande Grève

Diaphorostoma sp.

Page 149

18 A small shell with coarser sculpture and different contour than the foregoing. x 2

Grande Grève limestone. Indian Cove

Diaphorostoma perceense nov.

Page 149

22, 23 Two views of an average example showing size, contour and surface

Grande Grève limestone. Percé Rock

PLATE 16

Eotomaria voltumna (Billings)

Page 150

1, 2 Billings's type [*op. cit.* pl. 5, fig. 5, 5a]
Grande Grève limestone. Grande Grève

Eotomaria lydia (Billings)

Page 151

3, 4 Billings's type [*op. cit.* pl. 5, fig. 4, 4a]
Grande Grève limestone. Indian Cove

Trochonema lescarboti nov.

Page 152

5 View of the spire showing the excavate upper surface of the whorls
Grande Grève limestone. Percé Rock

Eotomaria delia (Billings)

Page 151

6, 7 Billings's type [*op. cit.* pl. 5, fig. 3]
8 A smaller specimen
17 A specimen doubtfully referred to this species. x 2
Grande Grève limestone. Grande Grève

Poleumita princessa (Billings)

Page 115

9, 10 Billings's type [*op. cit.* p. 59, fig. 29]
Cape Bon Ami beds (?) "Between Cape Gaspé and Cape Rosier"

Eotomaria (?) **rotula** nov.

Page 151

11 The sculpture at the periphery. x 5
12–14 Views of a typical example. x 2
Grande Grève limestone; division 2. Grande Grève

Pleurotomaria sulcomarginata Conrad var. **leclercqi**

Page 228

15, 16 Views showing the contour of the shell and its sculpture. x 2
Gaspé sandstone. Gaspé Basin

GASTROPODS

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Pleurotomaria labrosa Hall

Page 105

18 Fragment of a large individual restored in outline
St Alban beds. Cape Rosier Cove

Lophospira bilirata Hall

Page 106

19 A nearly entire example. x 2
St Alban beds. Grande Cavée, Griffon Cove river

Eotomaria ?

20 *Grande Grève limestone.* Grande Grève

Eotomaria cartieri nov.

Page 106

21, 22 Two views of a somewhat compressed specimen. x 1½
St Alban beds. Grande Cavée of Griffon Cove river

PLATE 17

Probolaeum ? canadense nov.

Page 105

1, 2 Opposite sides of the same specimen both showing the infolded anterior margin of the plate

St Alban beds. Cape Rosier Cove

Tropidocyclus rotalinea (Hall)

Page 229

3 Side view showing the lobation and spiral surface lines. x 3

4 Edge view showing the slit band. x 3

5 Side view of an imperfect specimen. x 3

6 Fragment enlarged to show sculpture. x 5

Gaspé sandstone. Gaspé Basin

Tropidocyclus brevilineatus (Conrad) (Hall)

Page 229

7 Apertural view of an internal cast showing the degree of lobation. x 3

8–11 Dorsal views with whorl sections. x 3

12 Side view showing the character of the surface. x 3

13 An example with somewhat coarser sculpture lines. x 3

14 Enlargement of sculpture. x 10

15, 16 Dorsal views showing the lines crossing the slit band and also the interrupted revolving lines. x 3

Gaspé sandstone. Gaspé Basin

Bellerophon (Plectonotus ?) gaspensis nov.

Page 154

17, 18 Dorsal and side views. x 1½

Grande Grève limestone; division 2. Grande Grève

Euphemus ? quebecensis nov.

Page 229

19, 20 Apertural views showing the absence of a slit band. x 2 and x 3

21, 22 Side views, showing the spiral sculpture and close umbilicus. x 3 and x 2

Gaspé sandstone. Gaspé Basin

GASTROPODS

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Bellerophon sp.

Page 230

23, 24 Views of the body and interior whorls of the same specimen, showing the character of the ornament. x 2

Gaspé sandstone. Gaspé Basin

Bellerophon plenus Billings

Page 153

25 Dorsal view of the apertural portion of the exterior

Grande Grève limestone. Lehuquet's Cove

26 A silica replacement of the inner whorls showing the linear spiral sculpture. x 5

27, 28 Views of an internal cast showing the explanate aperture. Parts of Orbiculoidea are attached to the specimen

Grande Grève limestone. Grande Grève

Coelidium egregium (Billings)

Page 152

29 Billings's type [*op. cit.* pl. 5, fig. 7]

30 One of Billings's originals. "Head of the Falls of the Dartmouth River"

Coelidium hebe (Billings)

Page 153

31, 32 Internal casts in the usual condition of preservation of this shell

Grande Grève limestone. Grande Grève

PLATE 18

Aviculopecten ? incrassatus nov.

Page 155

1 The original, with broad unequal concentrically lined ribs
Grande Grève limestone; division 2. Lehuquet's Cove

Pterinopecten proteus Clarke *mutation*

Page 156

2 The two valves in articulation

3 A left valve
Grande Grève limestone. Grande Grève and Indian Cove

Aviculopecten sp.

4 The interior of a right valve, probably not of the same species as the others

5 Internal cast of a left valve

6 Exterior of a right valve
Gaspé sandstone. Gaspé Basin

Pterinea textilis arenaria (Hall)

7 A nearly complete and finely preserved individual, drawn to show the characters of the exterior which have not before been correctly represented
Oriskany sandstone. Schoharie, N. Y.

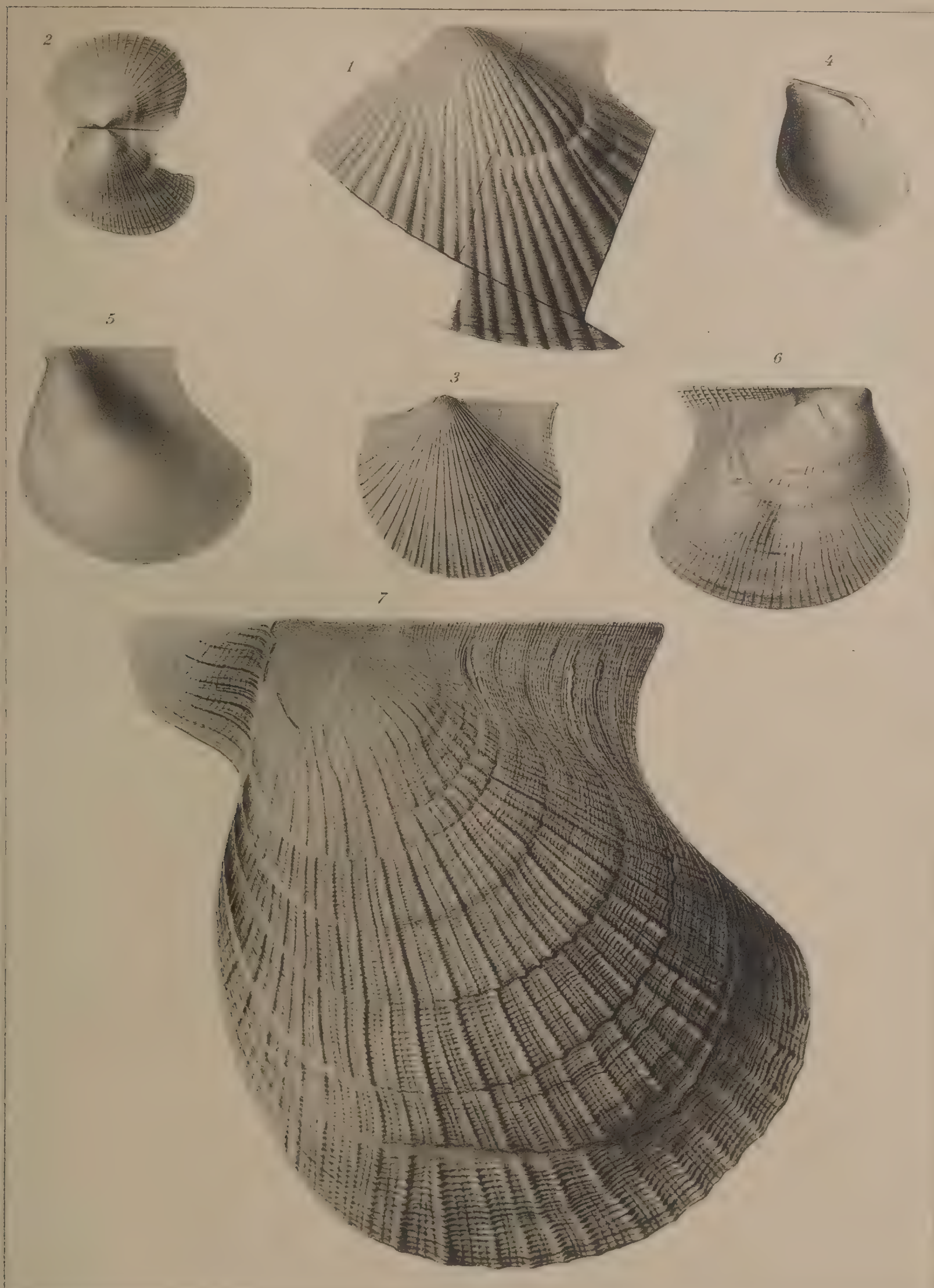

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PLATE 19

Actinopteria textilis (Hall)

Page 156

1 A small example

2 Enlargement of the surface

3 An incomplete mature individual

Grande Grève limestone; division 2. Grande Grève

Aviculopecten jumeaui nov.

Page 154

4, 5 Left valves showing the character of the exterior, the differences in outline being due to incomplete preservation of the latter

Grande Grève limestone. Percé Rock

Actinopteria (Pterinea) fronsacia nov.

Page 230

6 The external surface and sculpture of the left valve

Gaspé sandstone. Gaspé Basin

Pterinea ?

7 A left valve

Grande Grève limestone. Percé Rock

Actinopteria communis (Hall)

Page 155

8 A small left valve

Grande Grève limestone. Percé Rock

9, 10 Mature shells with some variation of sculpture

11 A smaller example

Grande Grève limestone; 9, 10, division 1 (Dolbel brook); 11, division 2 (Shiphead)

12 A large sculpture cast of the right valve

Grande Grève limestone. Percé Rock

Actinopteria sp.

13 A left valve

Grande Grève limestone. Percé Rock

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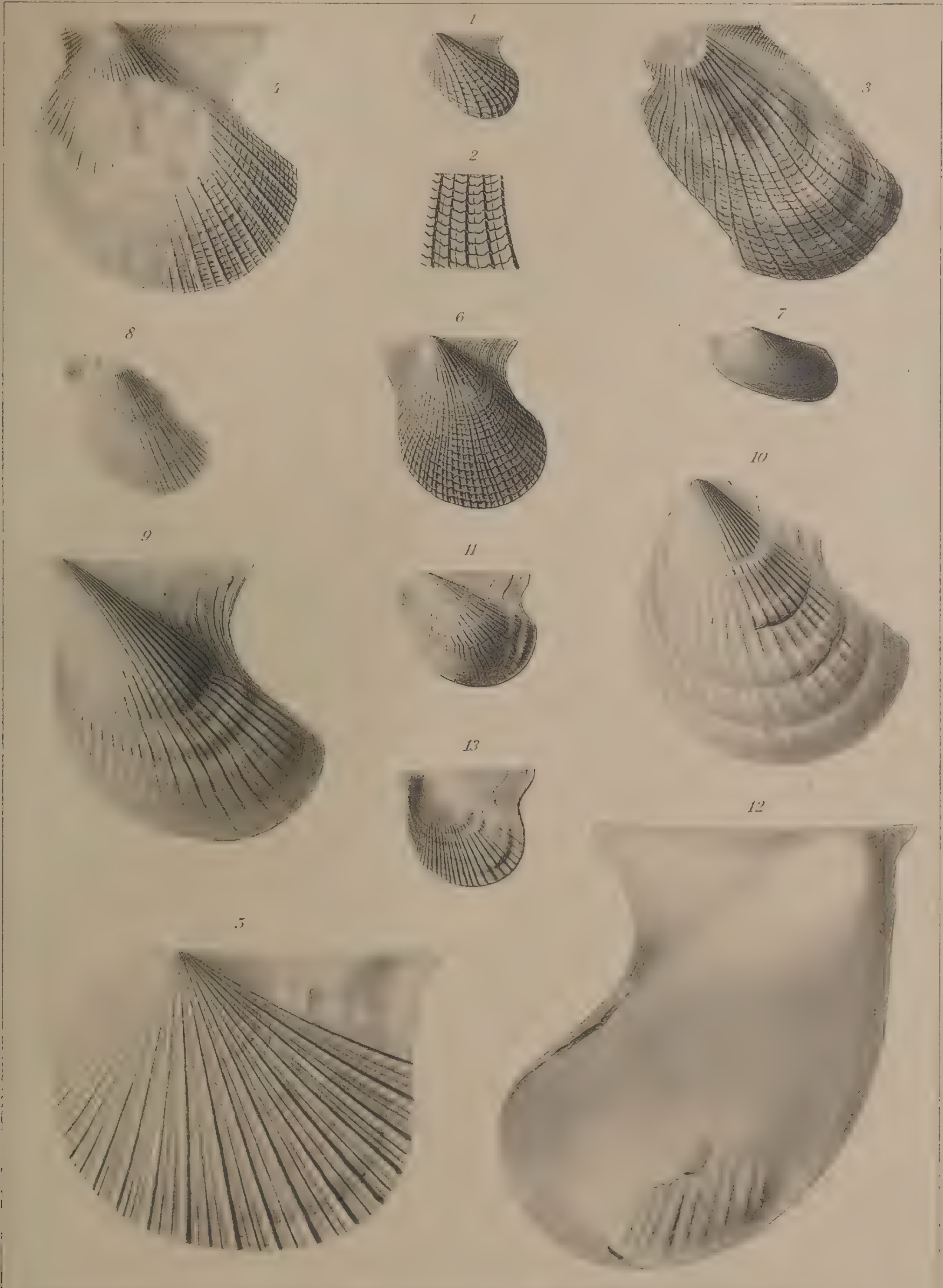

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PLATE 20

Limoptera rosieri

Page 106

1 A left valve showing the prominent varices and fainter radial lines

2 A sculpture cast in which the surface configuration is obscured but showing both concentric and radial markings and the striations of the ligament area

St Alban beds. Cape Rosier Cove

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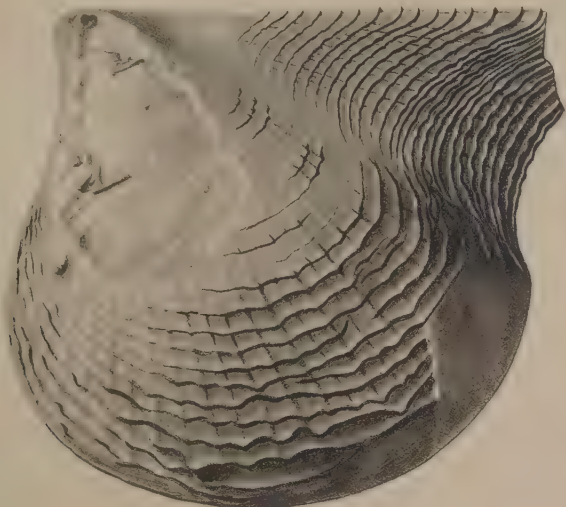

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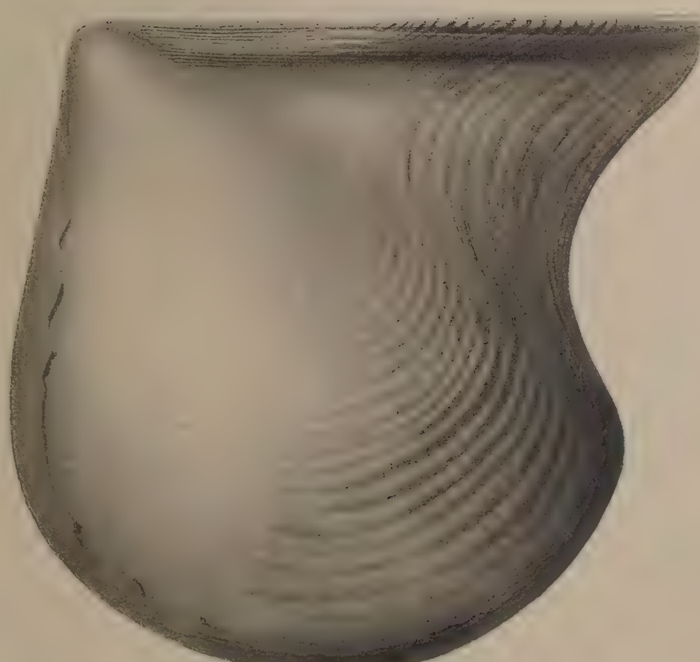

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PLATE 21

Palaeopinna flabellum Hall

Pages 159, 233

1 A left valve with attached specimens of Craniella ? grandegrevensis

Grande Grève limestone; division 2. Grande Grève

2 A left valve with the surface sculpture partially preserved and also carrying crania

St Alban beds. Cape Rosier Cove

3, 4 Right valves with characteristic exterior

5 Anterior view of combined valves showing the subumbonal depression

Grande Grève limestone; division 2. Little Gaspé

Megambonia crenistriata Clarke

Page 157

6, 7 Left valves with exterior and sculpture more or less completely retained

Grande Grève limestone. Figure 6, Dolbel brook, division 1; 7, Little Gaspé, division 2

Megambonia denysia nov.

Page 157

8, 9 Views of a typical specimen

10 A small shell with coarser plication. x 3

Grande Grève limestone. Percé Rock

G S Barkentin del

PLATE 22

Modiomorpha varia (Billings)

Page 160

1–3 Billings's originals of Modiolopsis varia, not before figured
Grande Grève limestone. 1, 2, Grande Grève; 3, Indian Cove

4, 5 Possible representatives of the same species
Grande Grève limestone. Grande Grève

Goniophora mediocris Billings

Page 161

6, 7 Views of the same example
Grande Grève limestone; division 1. Grande Grève

8 A specimen regarded as of this species but much compressed vertically
St Alban beds Cape Rosier Cove

Sphenotus truncatus (Conrad)

Page 232

9, 10 Right valves

11 A left valve

12 An incomplete right valve doubtfully referred to this species
Gaspé sandstone. Gaspé Basin

Phthonia cylindrica Hall

Page 232

13 A left valve. x $1\frac{1}{2}$
Gaspé sandstone. Gaspé Basin

Goniophora tethys (Billings)

Page 161

14–16 Views of the specimens in the Ottawa Museum identified as Billings's original of Sanguinolites tethys
Grande Grève limestone. Grande Grève

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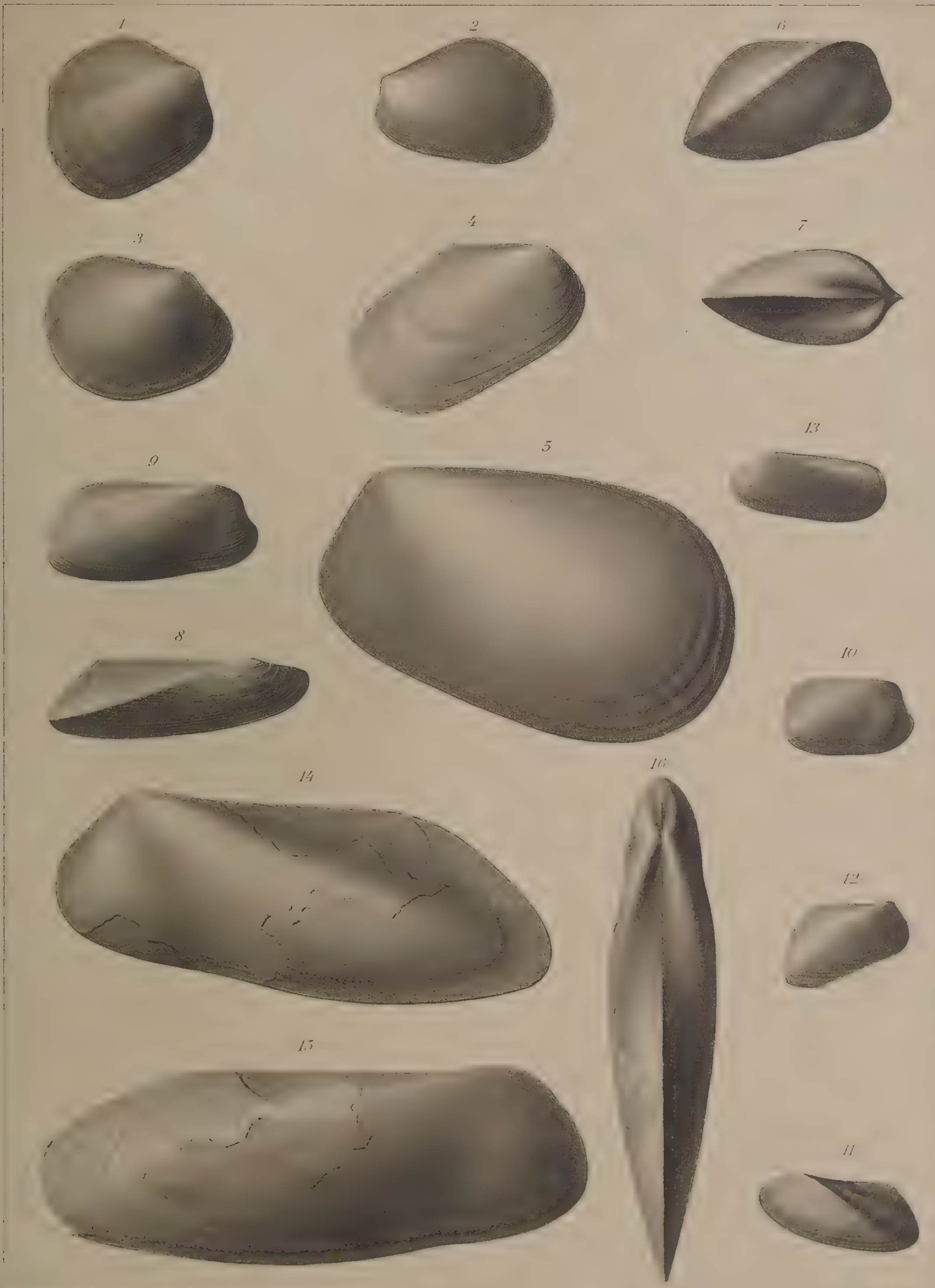

G.S.Barkentin del.

PLATE 23

Modiella modiola nov.

Page 232

1–5 Left and right valves
Gaspé sandstone. Gaspé Basin

Modiella pygmaea (Conrad)

Page 231

6 A right valve showing the ornamentation. x 3
7 Internal cast of this valve. x 3
Gaspé sandstone. Gaspé Basin

Conocardium cuneus (Conrad)

Page 162

8 An incomplete specimen
Grande Grève limestone. Grande Grève

Conocardium cf. **inceptum** Hall

9 An enlargement of the surface ornament. x 3
Chapman sandstone. Edmunds Hill, Chapman Plantation. Aroostook county, Maine
(Erroneously inserted here; *see* part 2)

Schizodus ventricosus (Billings) ?

Page 162

10 A left valve
Grande Grève limestone. Grande Grève

Schizodus appressus (Conrad)

Page 232

11 Sculpture cast of a right valve
Gaspé sandstone. Gaspé Basin

Lunulicardium ? convexum nov

Page 234

12 A right valve. x 5
Gaspé sandstone. Gaspé Basin

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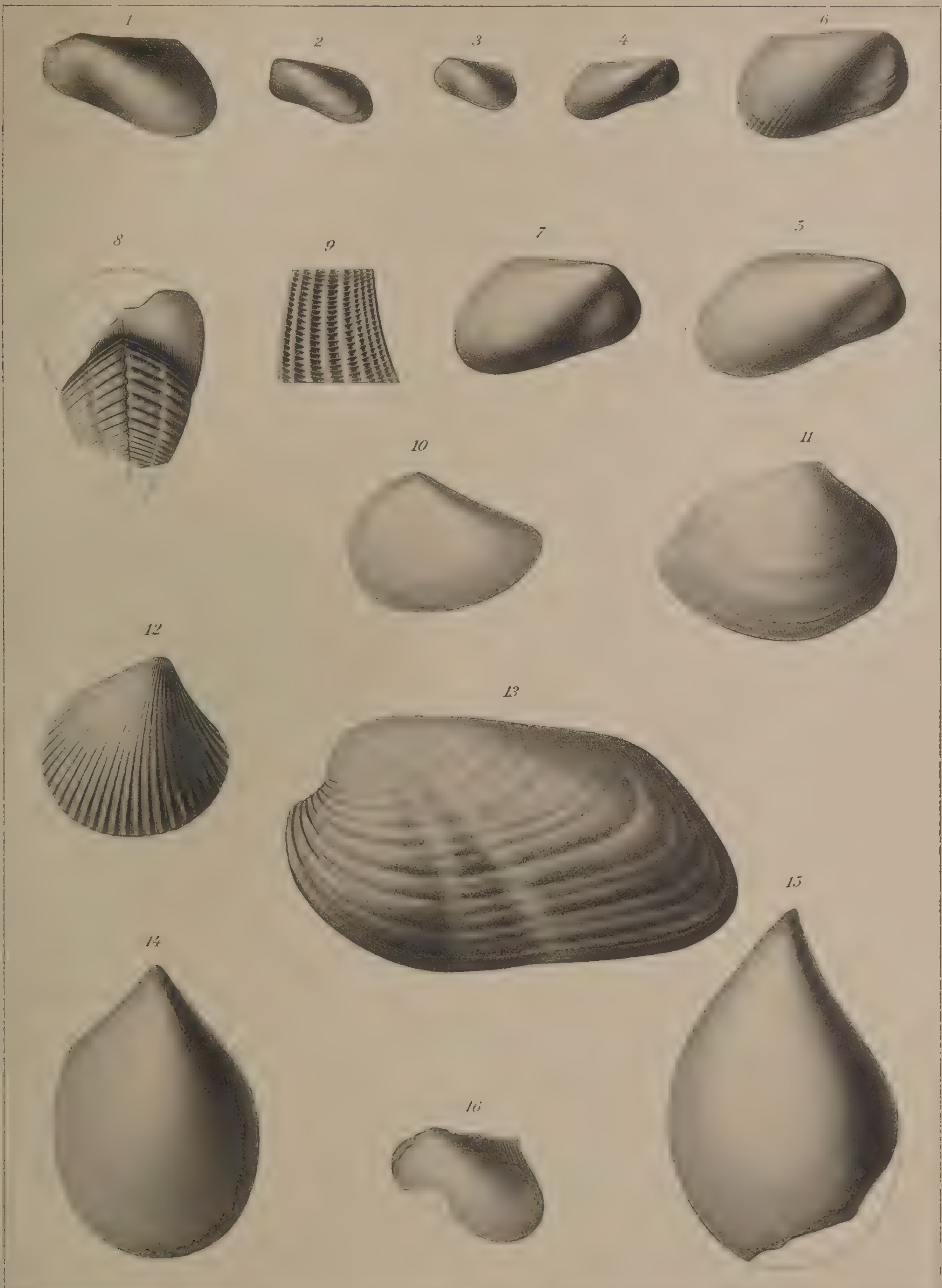

Grammysia canadensis Billings

Page 231

13 A characteristic left valve

Gaspé sandstone. Gaspé Basin

Mytilarca nitida Billings

Page 159

14, 15 Left and right valves in the form of limestone casts

Grande Grève limestone. Grande Grève

Liopteria ?

Page

16 A left valve of doubtful value. x 1½

Gaspé sandstone. Gaspé Basin

PLATE 24

Leda brevirostris Hall

Page 234

1 Exterior of a left valve. x 1½

2 Internal cast of a left valve. x 1½

3 Internal cast of a right valve with more extended posterior extremity and evidence of anterior muscular fulcrum. x 2

Gaspé sandstone. Gaspé Basin

Palaeoneilo maxima (Conrad)

Page 233

4, 5 Internal cast and exterior of a left valve

Gaspé sandstone. Gaspé Basin

Palaeoneilo cf. **constricta** (Conrad)

Page 233

6 A characteristic right valve

Gaspé sandstone. Gaspé Basin

Nuculites triquetrus Conrad

Page 233

7–10 Internal casts of both valves displaying the characteristic form and clavicle of this shell

Gaspé sandstone. Gaspé Basin

Nuculites sp.

Page 162

11 A small internal cast

Grande Grève limestone; division 2. Shiphead

Cypricardinia distincta Billings

Page 157

12 The exterior of a right valve retaining the ornament and showing the normal proportions of the species. x 3

13 A large valve with the sculpture destroyed

14, 15 Right valves; 15 x 3

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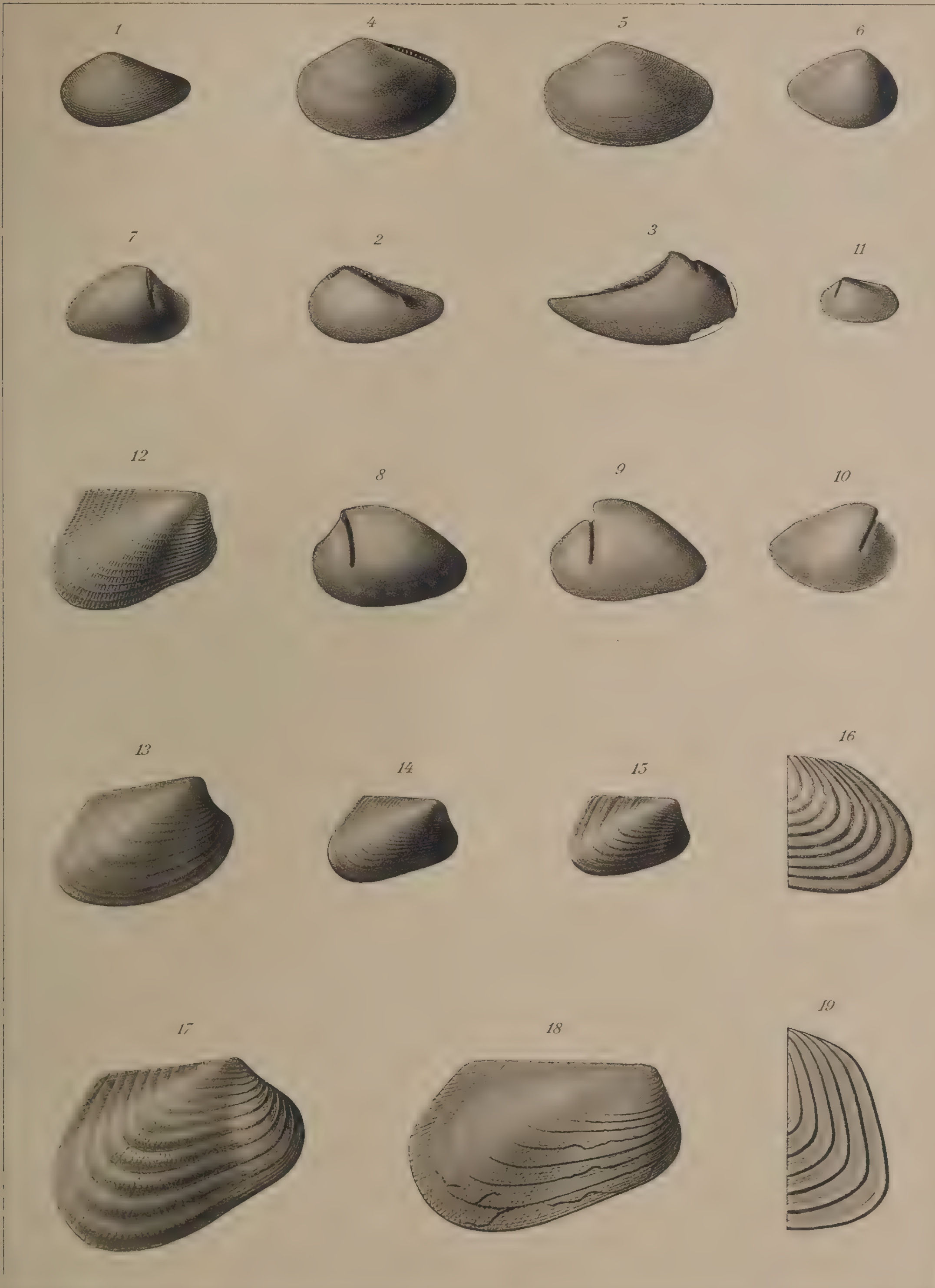


16 Enlargement of a specimen without the superficial ornament; showing strong concentric growth lines

17 A normal example with the sculpture retained on the concentric corrugations. x 2

18 A right valve in which the concentric structure is suppressed and the superficial ornament relatively pronounced. x 2

19 Enlargement of the posterior portion of a flattened left valve showing the coarse and fine concentric lines. x 3

Grande Grève limestone; division 2. At various points along the Forillon

PLATE 25

Centronella glansfagea Hall

Page 163

1–3 Views of an entirely characteristic specimen. x $1\frac{1}{2}$

4 Internal cast of a part of conjoined valves showing the muscle scars of the dorsal valve. x 2

Grande Grève limestone; division 2. Grande Grève

Cryptonella (?) **fausta** Clarke

Page 164

5–7 Specimens showing the general characters of the shell

Grande Grève limestone; division 2. Grande Grève

Cryptonella (?) **ellsi** nov.

Page 163

8–10 Views of a specimen showing the sloping prominent ventral umbo shoulders and broad pallial region. x $1\frac{1}{2}$

Grande Grève limestone; division 2. Grande Grève

Rensselaeria ovoides Eaton var. **gaspensis** nov.

(*See* plate 26)

Pages 164, 234

11 A small ventral valve

12 Profile of the ventral umbonal region with spondylium and supporting septum. x 2

13 Enlarged view of the dorsal hinge showing the crural plates. x 3

14 Sculpture cast of a small ventral valve with radial lines

15 Dorsal view of small finely striate example

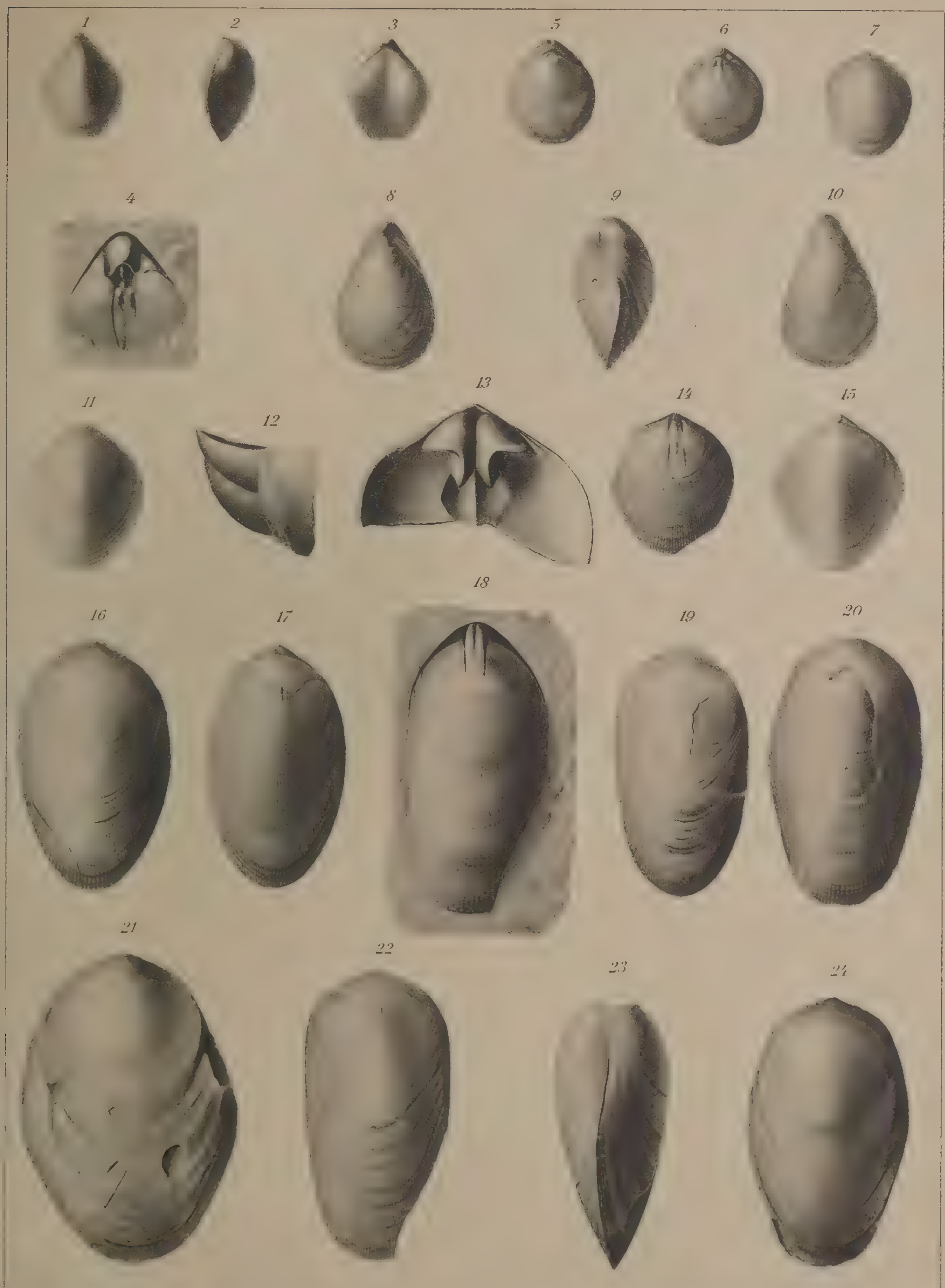
16, 17 Average adult examples

18 Internal cast of a ventral valve

19, 20 Other usual expressions of the shell

21 A broadly oval, somewhat flattened specimen

22 An elongate and narrow mature individual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23 Profile and ventral views

Of these specimens 11, 15–17, 19–24 are from the *Grande Grève limestone;* divisions 1–3. Grande Grève, Lehuquet's Cove, Indian Cove and elsewhere

12, 13, 14 and 18 are from the *Gaspé sandstone,* Gaspé Basin

PLATE 26

Rensselaeria ovoides Eaton var. **gaspensis** nov.

(*See* plate 25)

Pages 164, 234

1 Cast of small elongate dorsal valve

2 Cast of ventral valve

3 Ventral valve so broken as to show the spondylium
Gaspé sandstone. Gaspé Basin

4 Profile of conjoined valves

5 An extremely elongate and narrow shell
Grande Grève limestone. Percé Rock

Rensselaeria sp. ?

Page 166

6, 7 Dorsal and ventral valves with coarse plications
Grande Grève limestone; division 1. Grande Grève

Megalanteris thunei nov.

(*See* plate 27)

Page 168

8 Ventral valve preserving only a portion of the shell

9 A rather coarsely plicated dorsal valve regarded as questionably pertaining to this species

10, 11 Interior of the hinge portion of dorsal valves showing the character of the hinge plate
Grande Grève limestone; divisions 1 and 2. Grande Grève

12, 13 Opposite sides of a characteristic example
Grande Grève limestone. Percé Rock

Beachia amplexa nov.

Page 166

14–16 Three views of a typical example

17 Cast of ventral valve
Grande Grève limestone. Percé Rock

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PLATE 27

Megalanteris ovalis Hall

Page 167

1–3 Three views of a selicified replacement showing the exterior characters

4 Interior of a ventral valve giving details of internal structure

5 A silica replacement showing the structure of the brachidium

6 Interior of a dorsal valve

Oriskany limestone. Glenerie, N. Y.

Megalanteris thunei nov.

(*See* plate 26)

Page 168

7 Internal cast of the ventral valve

8, 9 Parts of dorsal valves to show the structure of the hinge plate. 8 x 2

10 Interior of the umbonal portion of the ventral valve

11, 12 Umbonal and profile views of conjoined valves enlarged to 1½ diameters to show the introversion of the margins

13 Dorsal view of a specimen which like most of the others has lost its superficial radial lines

14 Umbonal view of a specimen with very strongly inbent margins

15 Dorsal view of a shell with fine radial surface lines

Grande Grève limestone; divisions 1 and 2. Various localities along the shore of the Forillon

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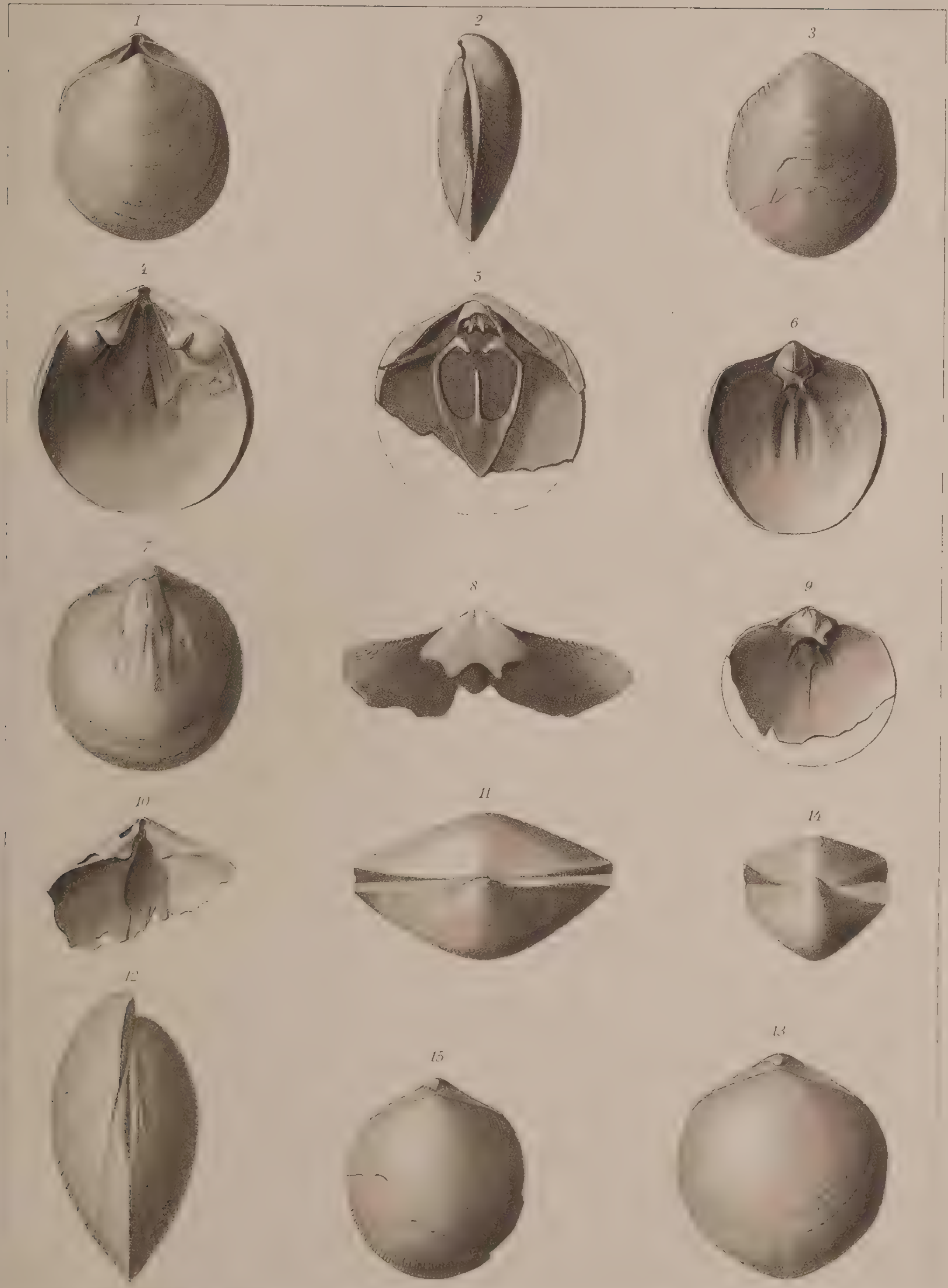

PLATE 28

Camarotoechia semiplicata (Conrad)

Page 108

1 Dorsal view. x 3
St Alban beds. Cape Rosier Cove

Camarotoechia dryope (Billings)

Page 170

2 Ventral view of a shell provisionally referred to this species
Grande Grève limestone; division 2. Grande Grève

Uncinulus mutabilis Hall

Page 171

3 Exterior of dorsal valve; a silica replacement
4 Internal cast of dorsal valve
5 Front elevation of conjoined valves; silica replacement
6, 7 Exterior of ventral valves
8 Interior of dorsal valve showing cardinal process, sockets and crura. x 3
Grande Grève limestone; division 2. Grande Grève and Indian Cove

Camarotoechia cf. **ramsayi** Hall

Page 168

9 Internal or sculpture cast of a ventral valve
Grande Grève limestone; division 2. Grande Grève

Plethorhyncha pliopleura (Conrad)

Page 171

10 Ventral valve
11–13 Views of a well defined example
14 Internal cast of ventral valve showing the small spondylium
15 Internal cast of dorsal valve
Grande Grève limestone; divisions 1 and 2. Lehuquet's Cove

Plethorhyncha barrandii Hall

Page 171

16, 17 Dorsal and ventral valves
Grande Grève limestone; divisions 1 and 2. Grande Grève

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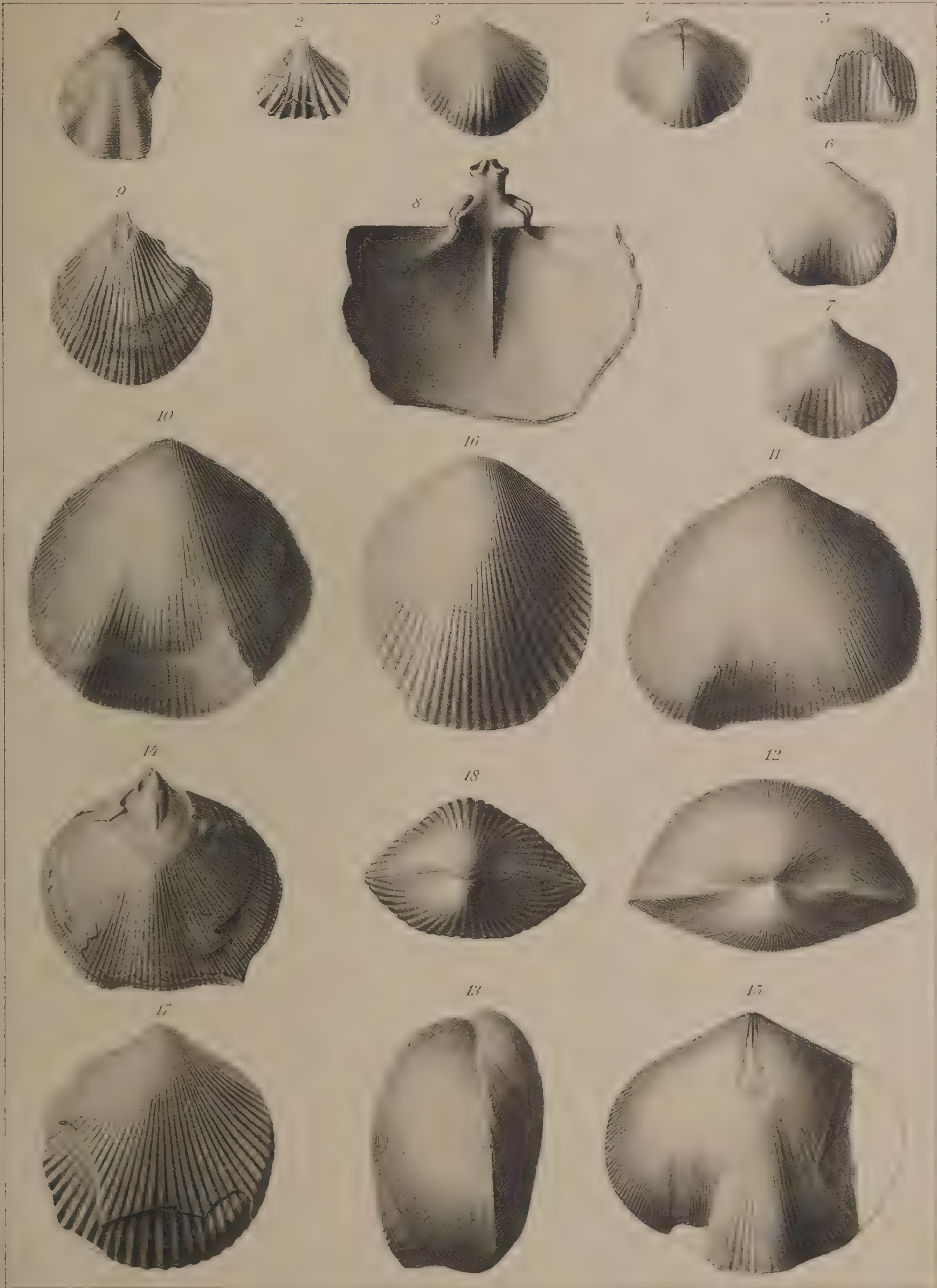

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Camarotoechia cf. **excellens** (Billings)

Page 169

18 Posterior view of a specimen provisionally referred to this species
Grande Grève limestone; division 2. Grande Grève

PLATE 29

Eatonia peculiaris (Conrad)

Pages 172, 234

1, 2 Opposite sides of an internal cast of the small form prevailing in the *Gaspé sandstone*

3, 4 Profile and dorsal views of the exterior

5, 6 Anterior and posterior views showing the elevation of the fold and the prominence of the median stria

7–10 Various views of well developed shells, some showing the projecting inner layers at the margin of fold and sinus

11 Internal cast of the ventral valve

12, 13 Ventral and dorsal views of an internal cast. x 2

Grande Grève limestone (except 1 and 2). Various localities along the Forillon

Rhynchospira globosa Hall

Page 109

14–17 Views of two specimens. x 2

St Alban beds. Cape Rosier Cove

Atrypina sp.

Page 109

18 Dorsal view of specimen showing the strongly lamellose surface. x 1½

St Alban beds. Griffon Cove river

Coelospira concava Hall

Page 175

19 Interior of a dorsal valve. x 3

20, 21 Exterior and interior of ventral valve. x 3

22 Interior of dorsal valve. x 3

Grande Grève limestone. Grande Grève

Leptocoelia flabellites (Conrad)

Pages 174, 235

23 Exterior of dorsal valve

24, 25 Interior of dorsal valves

26 Exterior showing tendency to division of plications at margin

BRACHIOPODS

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PLATE 30

Meristella champlaini nov.

Page 175

1–4 Views of a normal mature shell

5–7, 8, 9–11 Other examples with some degree of variation in the flattening of the ventral valve

12, 14 Anterior views, showing variations in the sinus

13 Internal cast of ventral valve

15 A profile

16, 17 Internal cast of a large, somewhat flattened ventral valve, and enlargement of the vascular surface

18 A small shell radially marked on the interior of the dorsal valve

19 Interior of a dorsal valve

20 Exterior of a large ventral valve

Grande Grève limestone; divisions 1 and 2. At various outcrops about Grande Grève, Lehuquet's and Indian Coves, and Shiphead

Meristella lata Hall

Page 177

21–23 The usual expression of this species at this locality, showing the broadly flattened body and umbonal slopes of the ventral valve

Grande Grève limestone. Percé Rock

24, 25 Exterior and interior of a silica replacement of the ventral valve

26 A dorsal valve

Grande Grève limestone. Grande Grève

BRACHIOPODS

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PLATE 31

Spirifer plicatus (Weller)

Page 181

1–13 Various views of silica replacements of this species, 9 and 13 natural size, all the rest x 1½, showing the usual expression, contour, mode and degree of plication of the valves

14 A ventral valve with median plication in the sinus, a less common feature than the low sinus on the fold of the dorsal valve. x 1½ [*see* fig. 7, 11, 13]

15, 16 Exterior and interior of a dorsal valve. x 1½

Grande Grève limestone. Grande Grève

17 Exterior of a dorsal valve with sulcate median fold and well developed concentric striae. x 1½

Grande Grève limestone. Percé Rock

This shell is far more abundant at Percé than on the Forillon, but the preservation at the former locality is less favorable for illustration of the species

Spirifer modestus Hall var. **nitidulus** nov.

Page 182

18–20 Three views of a silica replacement. x 5

21–23 A similar replacement. x 3

24 Interior of dorsal valve. x 5

Grande Grève limestone. Grande Grève

Cyrtina rostrata Hall

(=C. affinis Billings)

Page 183

25 Interior of dorsal valve. x 3

26–27 Posterior and anterior views of ventral valve

28 A younger and sparsely ribbed ventral valve. x 2. All are silica replacements

Grande Grève limestone. Grande Grève

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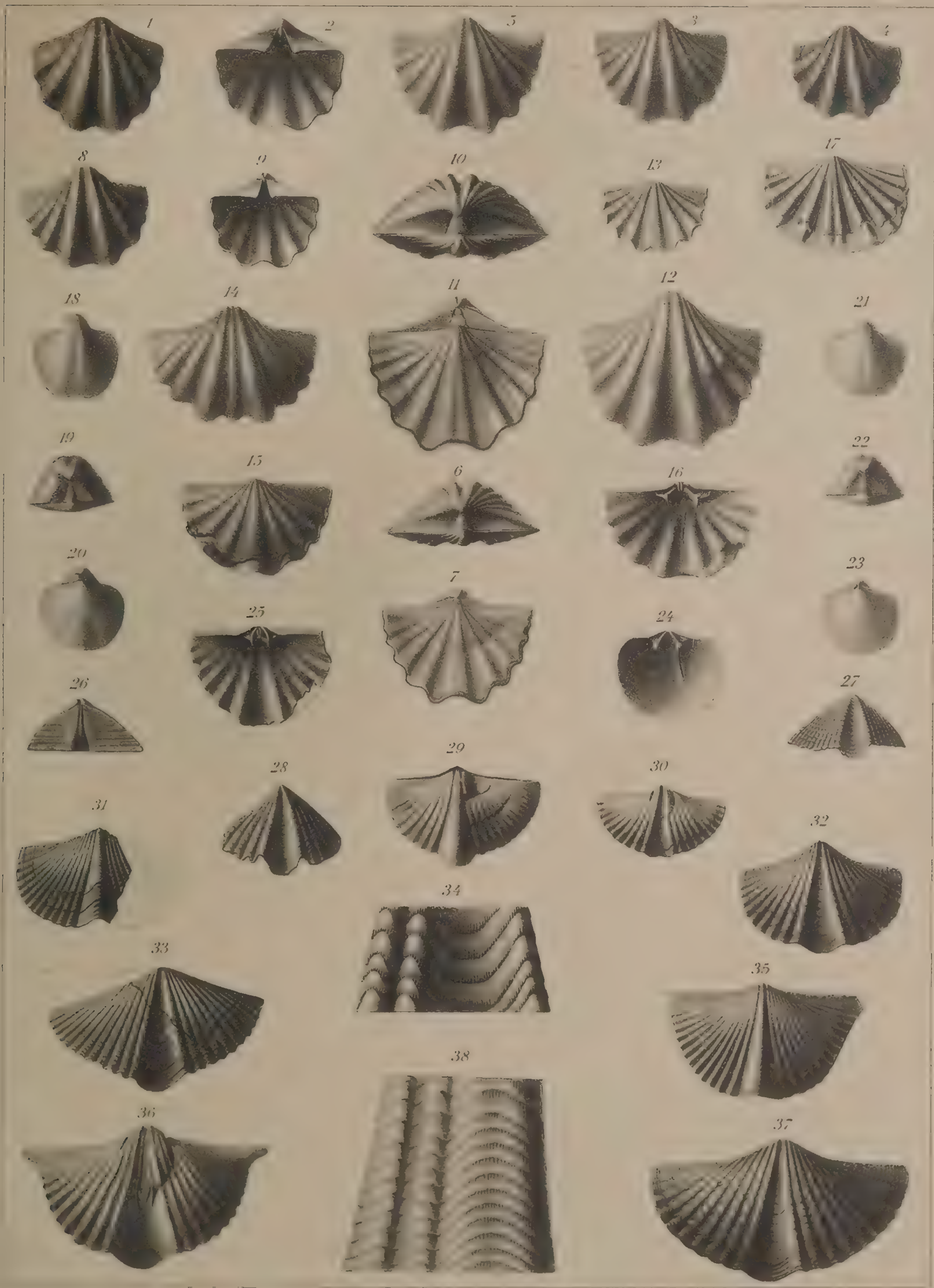

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Spirifer gaspensis Billings

Page 235

29, 30 Internal casts of dorsal and ventral valves

31, 32 Exterior of dorsal and ventral valves with characteristic lamellose surface. (32 x 2)

33 A slightly distorted ventral valve

34 Enlargement of a portion of the surface to show fimbriae. x 5

35 Internal cast of dorsal valve

36 Internal cast of ventral valve

37 A characteristic exterior of the ventral valve. x 2

38 Enlargement of surface of dorsal valve. x 4

Gaspé sandstone. Gaspé Basin

PLATE 32

Spirifer murchisoni Castelnau

Page 177

1, 2, 4 Ventral valves

3, 5 Dorsal valves

Grande Grève limestone. Percé Rock

6 Internal cast of dorsal valve

7 Silica replacement of ventral valve, inside view

8, 9, 10 Silica replacements of ventral valves retaining the surface characters

Grande Grève limestone; divisions 1 and 2. Grande Grève

Spirifer fimbriatus (Conrad)

Page 180

11–13 Three views of an excellent specimen, rare in this fauna, introduced for comparison with the following species. This species has duplicate spines on the fimbriae.

Oriskany siliceous limestone. Glenerie, N. Y.

Spirifer cyclopterus (Hall) Billings

Page 178

14 Cardinal view of one of Billings's originals

15 Enlargement of the surface. x 10

Grande Grève limestone. Percé Rock

16, 17 Opposite sides of another of Billings's original specimens

18 Internal cast of a ventral valve

19, 20 Exterior of ventral and dorsal valves

21 Enlargement of surface. x 5

Grande Grève limestone. Grande Grève

While figure 14 represents a very characteristic example of S. cyclopterus Hall, differing from S. fimbriatus in its more sharply defined ribs and simple fimbriae, figures 16–21 are of a type which allows ready inclusion within the conception of S. cyclopterus, but is not to be easily distinguished from either that of S. tribulis or of S. saffordi Hall, both species of the Cumberland Oriskany.

BRACHIOPODS

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Spirifer raricosta (Conrad) Billings

Page 181

22, 23 Views of Billings's original specimens
Grande Grève limestone. Grande Grève

Spirifer sp.

Page 183

24, 25 Ventral and dorsal valves of an unplicated species with well defined fold and sinus
Grande Grève limestone. Grande Grève

PLATE 33

Spirifer arenosus Conrad

Page 179

1, 3 Ventral valves of small specimen, showing the broad flattened ribs, narrow, sharp sulci, plicated sinus and striate surface

2 Internal cast of a dorsal valve

4–6 Rotund and short hinged ventral valves, in part exposing the adductor scars

7 Enlargement of surface showing the fine radial striae. x 3

8–10 Internal cast of ventral valves

Grande Grève limestone. Figures 1, 3, 7–10, from divisions 1 and 2. Grande Grève; 2, 4–6, from Percé Rock

Spirifer arenosus Conrad var. **unicus** Hall

Page 179

11 A ventral valve with greatly flexed sinus and elevated fold

Grande Grève limestone; division 2. Lehuquet's Cove

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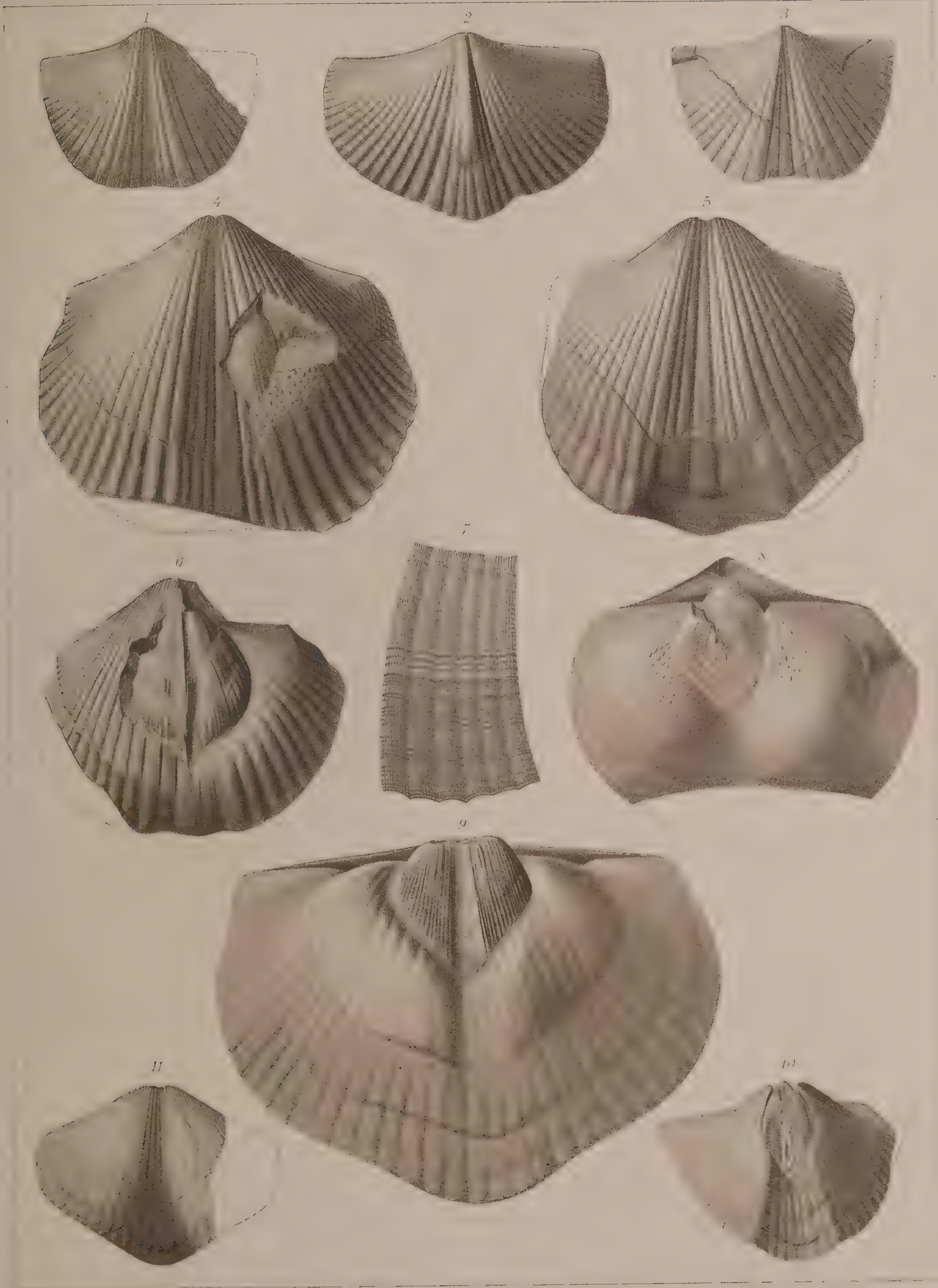
Memoir 9 N.Y. State Museum.



G.S Barkentin del.

PLATE 34

Leptaena rhomboidalis Wilckens

Pages 111, 183

1, 2 Two views of the characteristic expression of the species in the lower formations

St Alban beds. Grande Cavée, Griffon Cove river

3 A ventral valve

Grande Grève limestone. Grande Grève

Stropheondonta hunti nov.

Page 185

4 A ventral valve slightly corrugated at the umbo and with fine radial striae. x 2

5 A more broadly corrugated, auriculate valve. x 2

6 Enlargement of the cardinal areas. x 3

7 A ventral valve with broad corrugations and fine radii. x 3

8 A portion of the surface. x 10

9 Cardinal area of the dorsal valve showing the strong bifurcate cardinal process and the elevated denticulations which serve as accessory teeth. x 3

10–12 Other shells with somewhat varying exterior. (10 x 3 : 11 x 2 : 12 x 3)

Grande Grève limestone; division 2. Grande Grève

Athyris hera nov.

Page 236

13 A small ventral valve with narrow sinus and strong concentric lines. x 2

14 The type of the species. A large ventral valve with broad sinus

Gaspé sandstone. Gaspé Basin

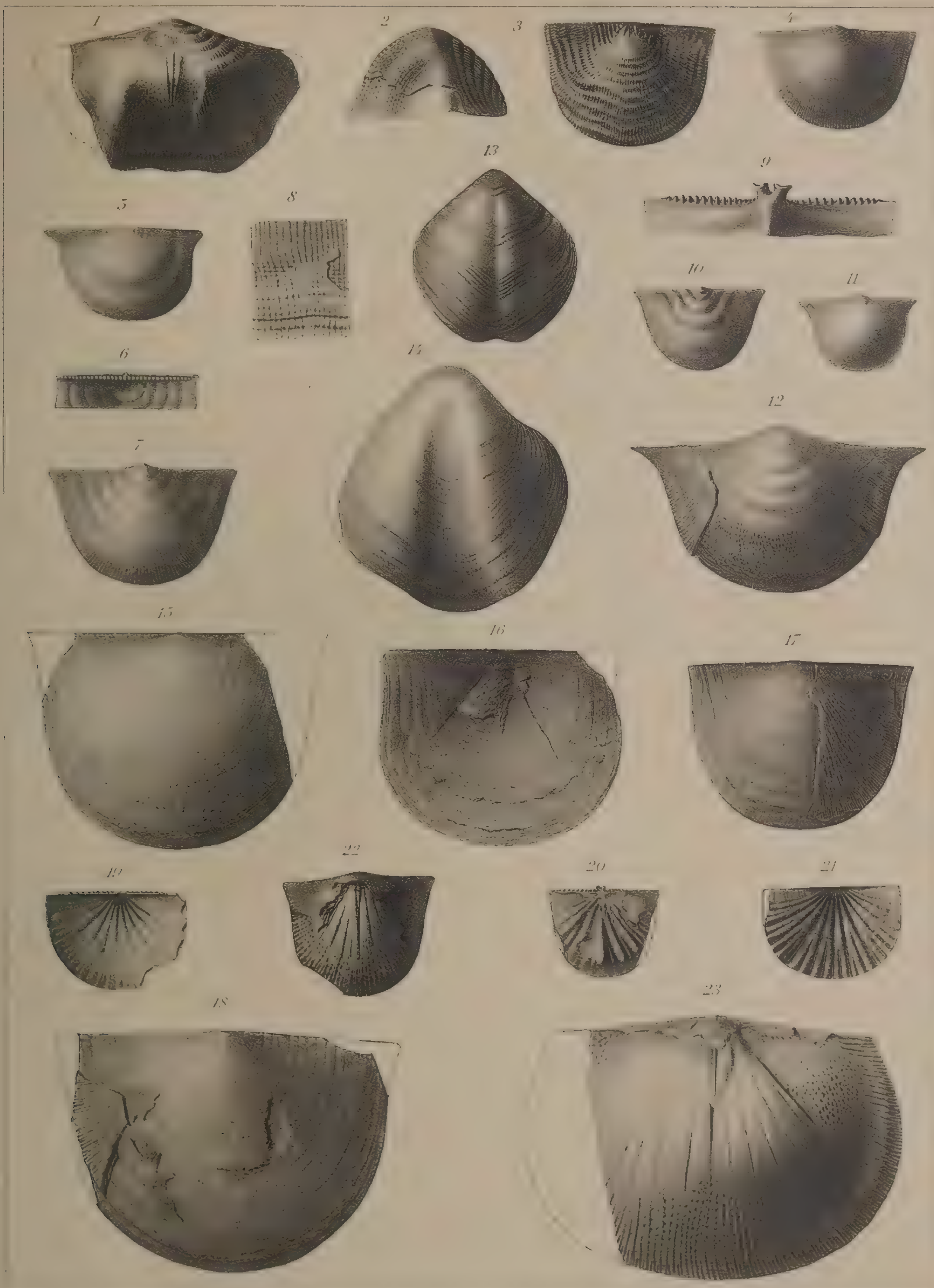
Stropheodonta lincklaeni Hall

Page 184

15 External cast of dorsal valve

16 Exterior of dorsal valve, showing a lamellose surface. The divergent lines from the beak are casual

BRACHIOPODS



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17, 18 External casts of dorsal valves with portion of the shell adhering
Grande Grève limestone; division 2. Grande Grève

Stropheodonta parva Hall

protype **avita** nov.

Page 188

19 Exterior of dorsal valve, showing broad and well divided fascicles of plications. x 2

20 Interior of dorsal valve with cardinal process and denticulations. x 2

21 Exterior of dorsal valve with fascicles but slightly divided. x 2
Grande Grève limestone; division 2. Grande Grève

Stropheodonta magniventer Hall

Page 184

22 A small ventral valve exposing the cast and showing the large flabellate muscle scar
Grande Grève limestone; division 2. Grande Grève

23 A large internal cast of the ventral valve
Grande Grève limestone. Percé Rock

PLATE 35

Stropheodonta rosieri nov.

Page 110

1, 2 Two shells showing somewhat different ontogenic progress and indicating the relation of these mature characters to S. v a r i s t r i a t a and S. p a t e r s o n i. x 2

St Alban beds. Cape Rosier Cove

Stropheodonta patersoni Hall protype **precedens** nov.

Page 186

3 A young shell showing the primitive character of the surface at this growth stage

4, 5, 7 Shells showing a gradual approach to normal mature conditions with fine subequal radii and umbonal crenulations

6 Enlargement of a portion of the surface in the pallial region, showing alternating radii and fine concentric lines. x 5

8 A ventral valve showing in strong contrast the incipient, adolescent and mature styles of sculpture

9–13 Other valves each showing a difference from the rest in growth phase. In figure 10, the sculpture is mature and ultimate and indicates acceleration which has virtually skipped the anephebic crenulations. The same expression is given by 12 which is the original of Mr Billings's S. i n e q u i r a d i a t a Hall. In 13 the long continuance of the anephebic condition is particularly noteworthy

Grande Grève limestone. At various localities on the Forillon. Figure 12 is from Indian Cove.

Stropheodonta crebristriata (Conrad) protype **simplex** nov.

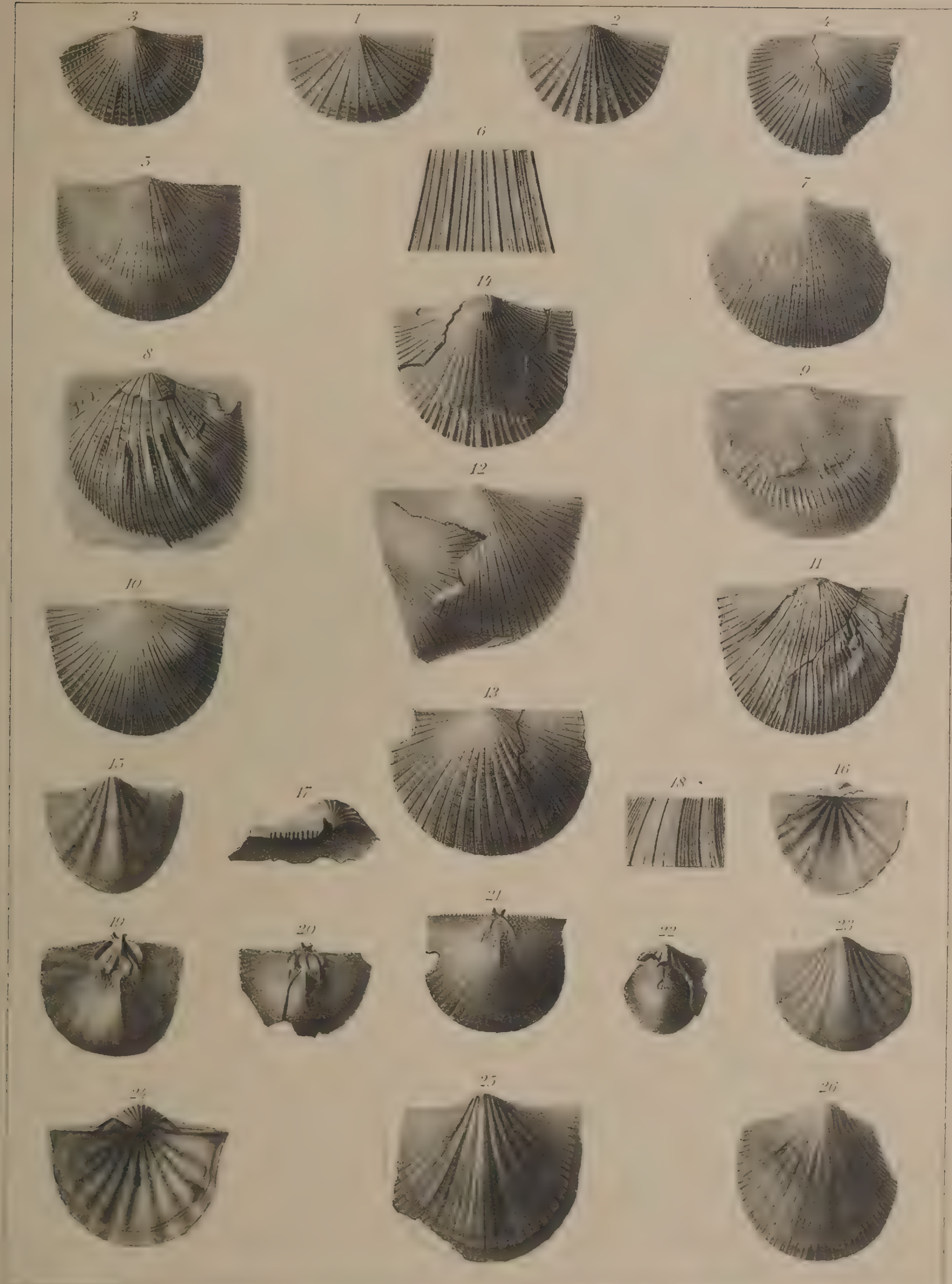
Page 187

14 A partially silicified ventral valve showing the character of the plications. x 2

Grande Grève limestone. Grande Grève

BRACHIOPODS

Memoir 9. N.Y. State Museum.



Stropheodonta galatea (Billings)

Page 188

15, 16 Opposite sides of a silicified specimen showing the character of the plications and the hinge. x 2

17 A portion of the hinge enlarged to show the denticulations. x 3

18 Enlargement of the surface striae from the same specimen. x 5

19–21 Interior of the brachial valves showing cardinal process, muscle scars and denticulate hinge. (19, 21 x 2)

22 A silica replacement showing the cast of the interior of the ventral valve

23 A ventral valve with very regular and undivided plications. x 2

24 Dorsal view of a specimen. x 2

25, 26 Ventral valves showing differences due to fasciculation of the ribs and development of the radial striae. x 2

Grande Grève limestone; division 2. Grande Grève

PLATE 36

Brachyprion majus Clarke

Page 190

1 Partial exterior of a ventral valve

2, 3 Interior of dorsal valves

4 Enlargement of surface sculpture. x 5

5 Internal cast of large ventral valve

6 Sculpture cast of ventral valve showing the normal character of the surface

Grande Grève limestone; division 2. Grande Grève

Leptostrophia oriskania Clarke

Page 194

7, 9, 12, 14, 15, 18 Exteriors of ventral valves showing the variations in the aspect of the exterior

8 Exterior of a dorsal valve

10 Internal cast of ventral valve

11 Interior umbonal portion of a ventral valve. x 2

13 Exterior of a dorsal valve with oblique crenulations at the cardinal angles

16 Enlargement of the surface

17 Interior of a dorsal valve

Grande Grève limestone; division 2. Grande Grève

Leptostrophia blainvillii (Billings)

Page 237

19 Internal cast of a ventral valve

20 Interior of a ventral valve

21, 22 Exteriors of ventral valves

23 Interior of a dorsal valve

24 Exterior of a ventral valve with attached Hederella blainvillii

Gaspé sandstoen. Gaspé Basin

BRACHIOPODS

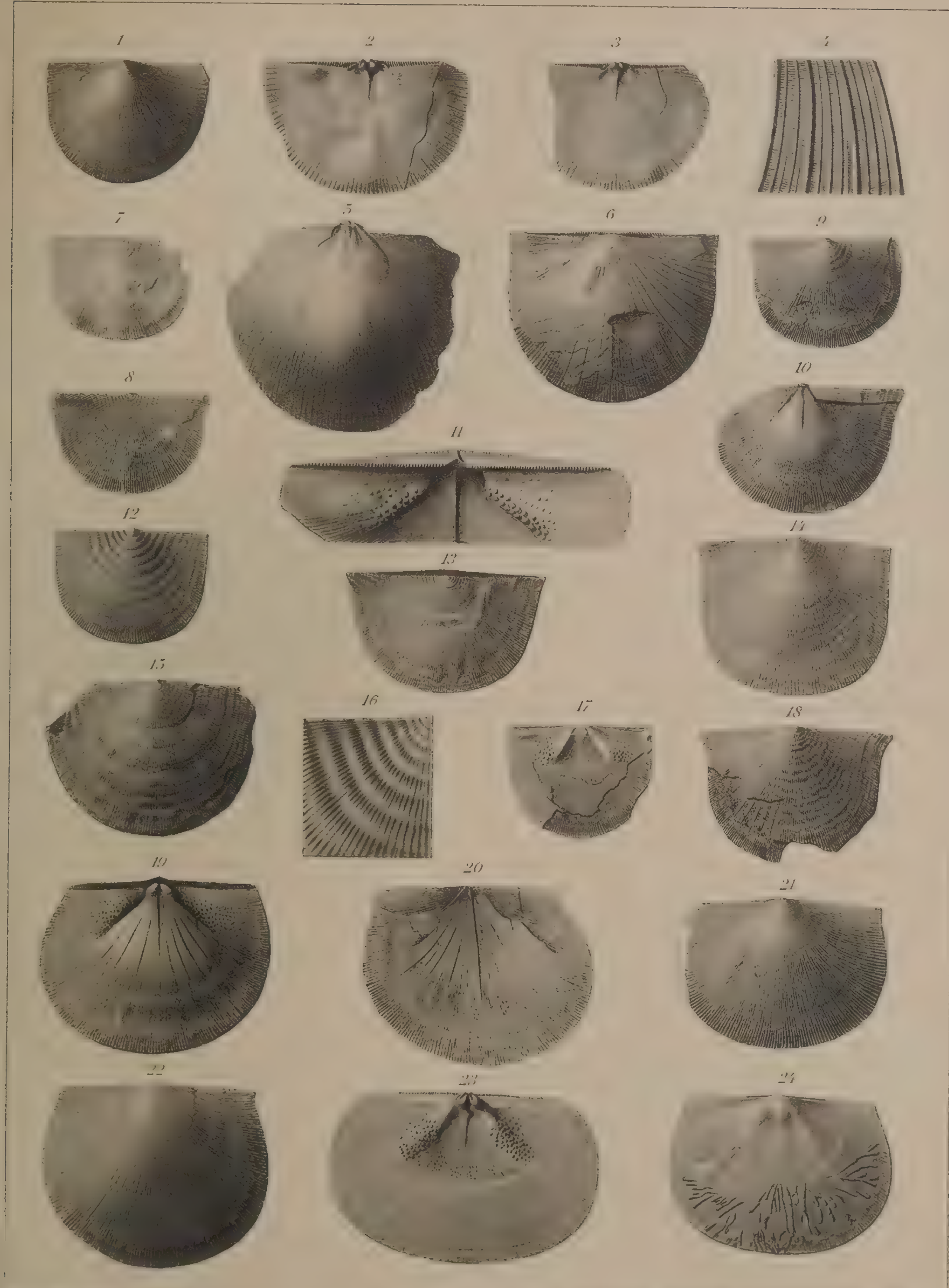


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PLATE 37

Leptostrophia magnifica var. **tullia** (Billings)

Page 191

1 A normal ventral valve
2 Enlargement of sculpture
3 Internal cast of ventral valve
4 A ventral valve with oblique corrugations on the hinge
5 A larger and more transverse shell
6 A partial internal cast of the ventral valve. This is Billings's original
Grande Grève limestone. Percé Rock

Strophonella leavenworthana Hall

Page 111

7, 9 Dorsal valves showing the concave visceral region and deeply deflected margins
8 Internal cast of the dorsal valve
St Alban beds. Grande Cavée, Griffon Cove river

Strophonella punctulifera (Conrad)

Page 111

10 A somewhat exfoliated ventral valve
11 External cast of ventral valve
St Alban beds. Cape Rosier Cove

Strophonella ampla Hall

Page 197

12 External cast of a ventral valve
Grande Grève limestone; division 2. Grande Grève

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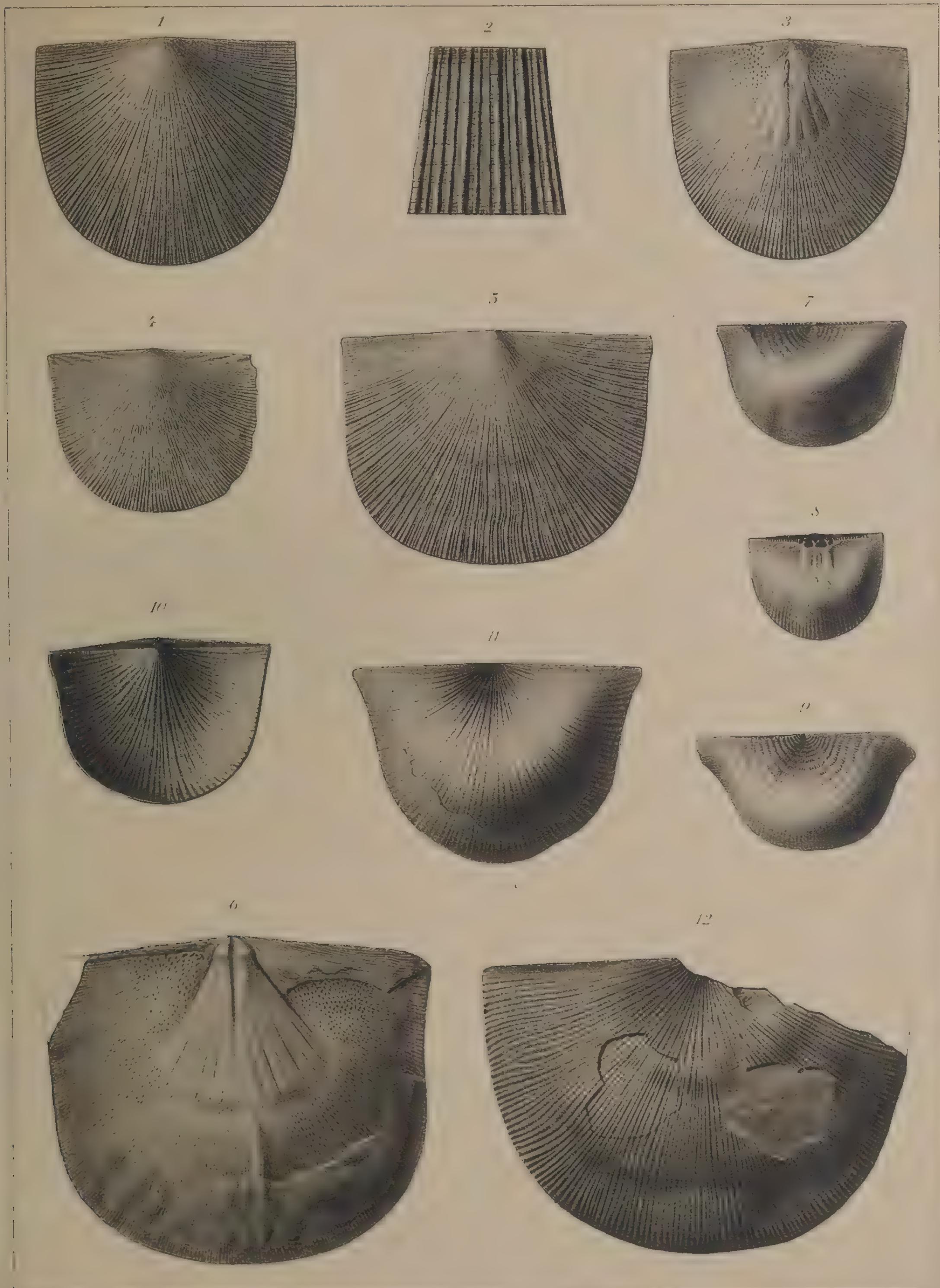

PLATE 38

Leptostrophia magnifica Hall

(*See* plate 39)

Page 190

1 Dorsal view of an average specimen with crenulated cardinal angles and the surface bearing Spirorbis and Crania

2 Ventral valve of a well preserved specimen

Grande Grève limestone; division 1. Grande Grève

Leptostrophia irene (Billings)

(*See* plate 39)

Page 193

3 Internal cast of a large ventral valve, showing the character of the muscle scar and the denticles on the hinge line

Grande Grève limestone; division 1. Grande Grève

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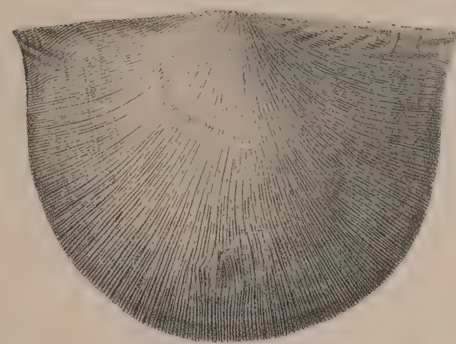
1

2



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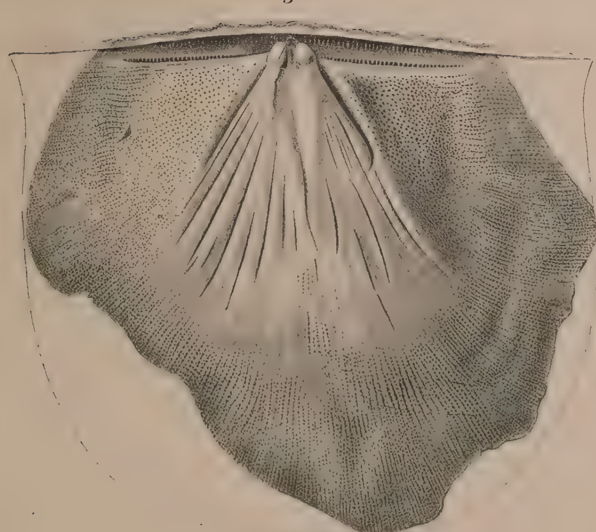

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PLATE 39

Leptostrophia tardifi nov

Page 195

1, 2 Exterior of ventral valves

3, 4 Surface. x 5

Grande Grève limestone. Percé Rock

Leptostrophia irene (Billings)

(*See* plate 38)

Page 193

5 Enlargement of surface. x 3

6, 7 Exterior of ventral valves

8 Internal cast of a small ventral valve

Grande Grève limestone. Grande Gréve

Leptostrophia magnifica Hall

(*See* plate 38)

Pages 111, 190

9 Enlargement of sculpture; from plate 38, figure 2. x 5

10 Exterior of a ventral valve

St Alban beds. Cape Rosier Cove

BRACHIOPODS

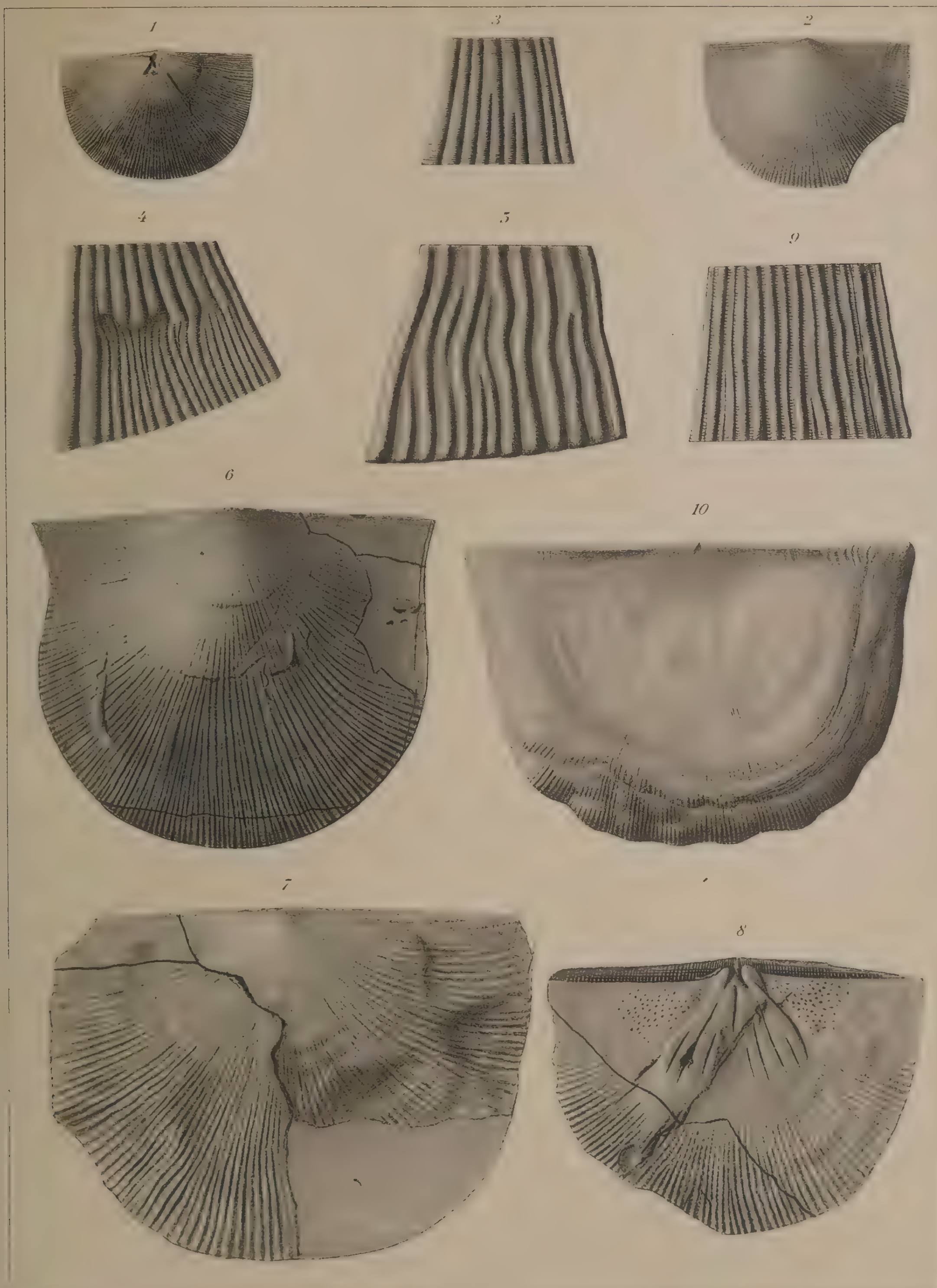


PLATE 40

Strophonella (Amphistrophia) continens nov.

Page 195

1 The exterior of a dorsal valve. The ventral behind it

2 Interior of the umbonal portion of a ventral valve, showing the outline of the muscle scars

3 A ventral valve with the sharp umbonal plications retained and exposing the internal cast over the rest of the surface

4 External cast of a ventral valve

5 Enlargement of the surface. x 3

6, 7 Partially exfoliated ventral valves

8, 9 External cast and exterior of the same ventral valve

10 Interior of a dorsal valve

11 A ventral valve, showing the sharp, simple umbonal plications, the gradual fasciculation and ultimate fine subdivision of the striae

Strophonella continens var. **equiplicata** nov.

Page 196

12 A ventral valve, showing the characteristics of the variety which are the protracted continuation of the simple plication peculiar to early growth phases of S. continens

13 An enlargement of the surface, showing the angular plications and broad grooves with their concentric lines. x 5

Strophonella continens var. **equalis** nov.

Page 197

14 External cast of a ventral valve

15 Exterior of a ventral valve. These specimens, showing the predominance of fasciculation over the entire surface of the shell

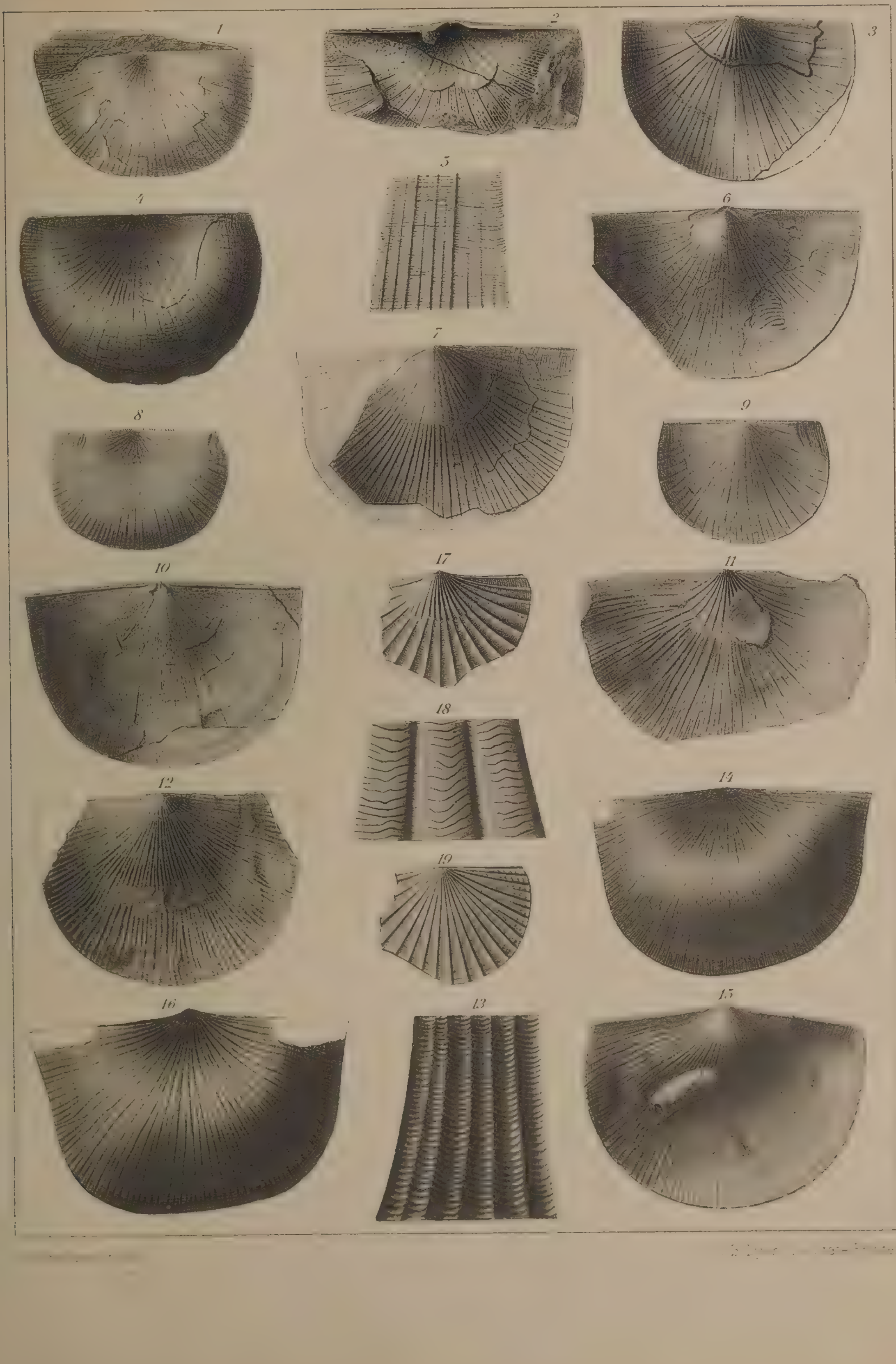
Strophonella continens var. **senilis** nov.

Page 197

16 External cast of the ventral valve in which the fine striation peculiar to senile stages of S. continens prevails over most of the shell and indicates acceleration of growth

Grande Grève limestone; division 2. Grande Grève, Lehuquet's Cove, Indian Cove and Shiphead

BRACHIOPODS



Gaspesia aurelia (Billings)

Page 198

17, 19 Views of incomplete specimens of these shells which have an apparently central beak, simple narrow elevated ribs with very broad interspaces

18 The sculpture of the surface drawn from an impression of the exterior in which the relief is reversed. x 5

Grande Grève limestone; division 2. Grande Grève

Orthothetes (Schuchertella) becraftensis Clarke

Pages 199, 238

1 Interior of a dorsal valve, a silica replacement, showing the simple surface plications x 2

2, 4, 5 Views of the ventral valve

3 Dorsal view of a flattened specimen

6, 7 Silica replacement of a ventral valve. x 2

8 Internal cast of a ventral valve

Grande Grève limestone; division 2. Grande Grève

Orthothetes (Schuchertella) woolworthanus Hall mut. **gaspensis nov.**

Page 199

9, 10 Interior of dorsal valves

11 Dorsal aspect of an internal cast, showing muscle scars and pallial markings

12 Internal cast of ventral valve, showing highly developed adductor scars

13 Interior of dorsal valve, a silica replacement

Grande Grève limestone; divisions 1 and 2. Grande Grève

Orthothetes (Schuchertella) woolworthanus Hall

Page 112

14 Internal cast of ventral valve

St Alban beds. Cape Rosier Cove

Anoplia nucleata Hall

Page 211

15 Internal cast of ventral valve enlarged to show the filling of the spine tubes crowning the cardinal area. x 10

16 Interior of a dorsal valve. x 3

17 Internal cast of ventral valve. x 3

Grande Grève limestone; division 2. Grande Grève

Chonetes billingsi nov.

Pages 209, 238

18 Ventral valve. x 2

19 Dorsal view of a specimen, bearing a spine near the cardinal angle. x 2

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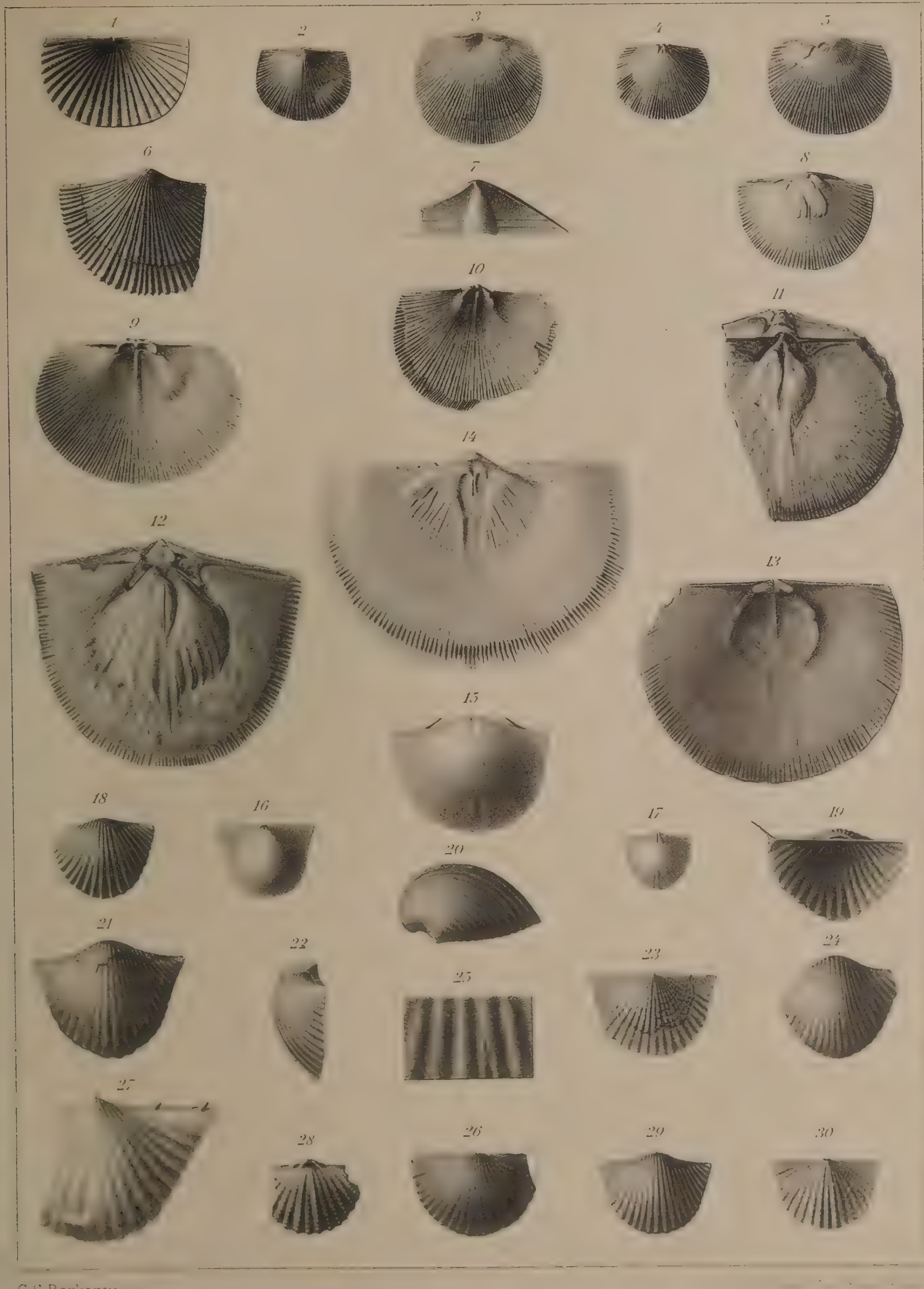

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20 Side view of ventral valve, showing convexity. x 2

21, 22 Views of a ventral valve. x 2

23 Interior of a dorsal valve. x 2

24 A ventral valve. x 2

25 Enlargement of sculpture. x 5; from fig. 26

26 External cast of dorsal valve, showing the fine concentric sculpture. x 2

27 A portion of the two valves, showing cardinal spines. x 4

28, 30 Interior of dorsal valves. (28, x 3; 30, x 2)

29 Ventral valve. x 2

Grande Grève limestone; division 2. Grande Grève

PLATE 42

Rhipidomella musculosa Hall

(*See also* plate 43)

Page 201

1 The interior of a dorsal valve

2–4 Specimens representing the exterior and internal casts of ventral valves

5 Interior of a ventral valve. All the foregoing specimens are silica replacements of the shell

Grande Grève limestone; division 1. Grande Grève

Hipparionyx proximus Vanuxem

Page 200

6 Interior of a small ventral valve, regarded as pertaining to this species. Specimens of larger dimensions also occur at this locality

Grande Grève limestone. Percé Rock

7, 8 Silica replacement of the dorsal valve. Interior and exterior views

9 The cardinal process viewed from behind

10 Interior of a ventral valve

11 Internal cast of a dorsal valve

Grande Grève limestone; division 1. Grande Grève

BRACHIOPODS

PLATE 43

Dalmanella penouili nov.

Page 242

1, 3 Views of ventral valve. x 3

2 View of dorsal valve. x 3

4 A smaller ventral valve. x 3

Gaspé sandstone. Gaspé Basin

Orthostrophia canadensis nov.

Page 112

5 Internal cast of ventral valve. x 1½

St Alban beds. Grande Cavée, Griffon Cove river

6 Internal cast of dorsal valve

St Alban beds. Cape Rosier Cove

Rhipidomella lehuquetiana nov.

Page 202

7 Interior of ventral valve restored at the left. x 2

8, 9 Interior of dorsal valves. x 2

10, 11 Exterior and interior of a ventral valve, showing the character of the shell, the senile expression of the foramen and cardinal thickening, and the large size of the adductor scars. x 2

12 Interior of ventral valve in which the adductor scars are obscure. x 2

13 Exterior of a ventral valve. All these are from silica replacements

Grande Grève limestone. Grande Grève

Rhipidomella musculosa Hall

(*See* plate 42)

Page 201

14 Cardinal view of the dorsal valve, showing the process and crura; a silica replacement. x 2

17, 19 Internal casts of brachial valves

20 Exterior of a ventral valve; a silica replacement

22 Interior of a ventral valve; a silica replacement

Grande Grève limestone; divisions 1 and 2. Grande Grève

BRACHIOPODS

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Rhipidomella logani nov

Page 202

15 Exterior of a small ventral valve

16 Internal cast of ventral valve

18 A ventral valve

21 Internal cast of a small ventral valve

Grande Grève limestone; divisions 1 and 2. Grande Grève

PLATE 44

Dalmanella sp. cf. **concinna** Hall

1–3 Three views of a mature specimen

4, 5 A young specimen. x 2

St Alban beds. Cape Rosier Cove

Dalmanella subcarinata Hall

Page 112

6, 7 Cardinal and profile views

St Alban beds. Cape Rosier Cove

Dalmanella lucia (Billings)

Page 204

8, 9 Views of Billings's original specimen

10, 11 Dorsal and profile of another example. x 1½

12, 13 An incomplete specimen. x 1½

14 Interior of dorsal valve. x 1½

15–17 Views of a silica replacement. x 1½

18 Interior of a dorsal valve. x 1½

Grande Grève limestone; division 2. Grande Grève

19, 20 A silicified shell having the characters of this species

Oriskany limestone. Glenerie, N. Y.

Schizophoria ? amii nov.

Page 204

21 Internal cast of ventral valve

22–24 Ventral and profile and dorsal views. x 1½

25 A dorsal valve

Grande Grève limestone. Grande Grève

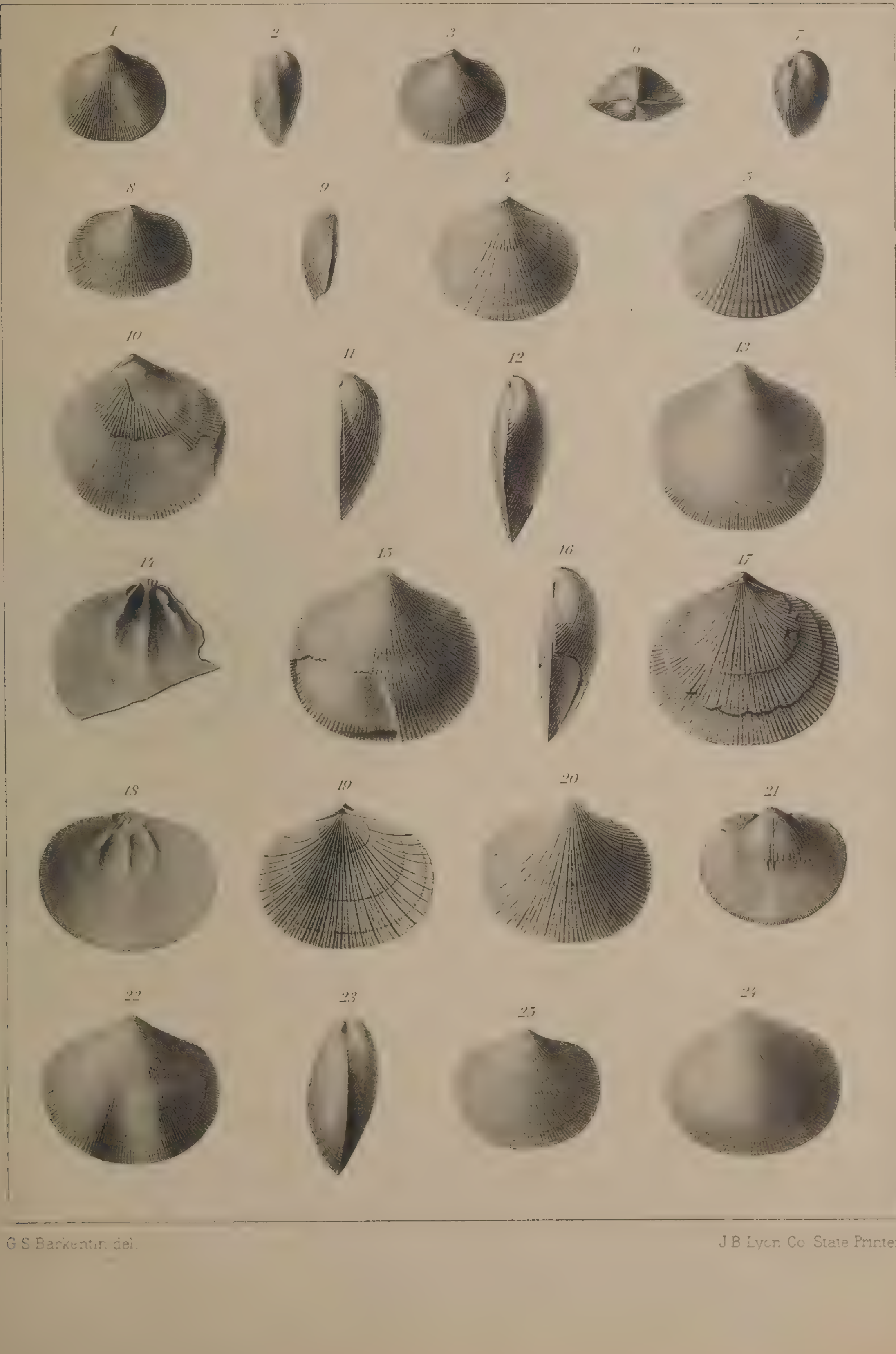

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PLATE 45

Chonetes (Eodevonaria) antiopa Billings

(*See* plate 46)

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1 A ventral valve mostly an internal cast. x 3

2, 3 Exterior of ventral valves. x 3

4 Interior of ventral valve. x 3

5 Billings's original mostly a ventral cast. x 2

Grande Grève limestone. Percé Rock

Chonetes (Eodevonaria) hudsonicus Clarke and metatype **gaspensis nov.**

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6–9 Internal casts of ventral valves

10 Enlargement of squeeze taken from specimen 6 to illustrate the character of the denticulate hinge. x 3

11 Interior of a dorsal valve. x 2

12 The ventral hinge taken from a squeeze enlarged from figure 7, showing coarse denticulation and the prominence of the median septum

13 A coarsely ribbed example. x 2

14 A ventral valve. x 2

15 Exterior of dorsal valve

Gaspé sandstone. Gaspé Basin

Chonetes canadensis Billings

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16, 17 Young shells. x 7

18 The spined cardinal area of the ventral valve

19 A very young shell. x 10, showing the median stria and smooth protegulum

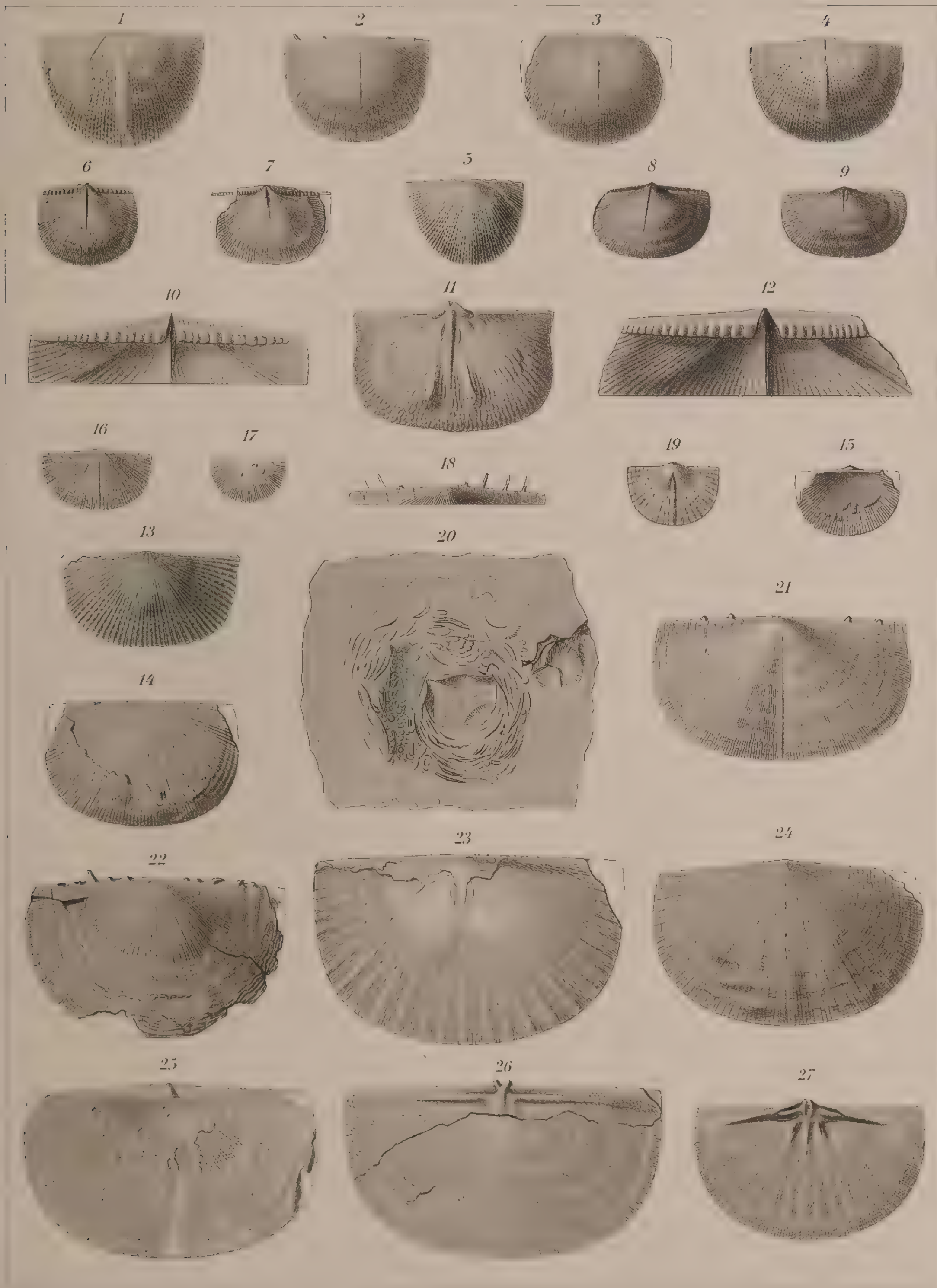
20 A mass of young shells for the most part in sections, grouped in vertical position about a center

21 Exterior of adult ventral valve with very strong median stria

22 Exterior of ventral valve

23 Partial internal cast of ventral valve, showing impressions of the radial sinuses of the pallial surface

BRACHIOPODS



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24 A ventral valve

25 Dorsal exterior view

26 Interior of the cardinal part of the dorsal valve with hinge process; showing also a mold of the external surface

27 Interior of the dorsal valve, showing the cardinal process and very long oblique sockets and socket walls

Grande Grève limestone; divisions 1, 2, 3. Figures 16–18, 20, 24, 25, 27, division 1. Grande Grève; 19, 21, 22, 23, 26. Percé Rock

PLATE 46

Chonetes melonicus Billings

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1 Dorsal view of an impression of the exterior. Billings's original

2 Internal cast of a ventral valve, showing place of septum and muscle scars. x 2

3 A portion of the dorsal valve, viewed from without, showing the cardinal process. x 3

4 Exterior mold of the dorsal valve

Grande Grève limestone. Grande Grève

Chonetes antiopa Billings

(*See* plate 45)

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5 Exterior of a ventral valve. x 3

Grande Grève limestone. Grande Grève

Chonostrophia complanata Hall

Pages 210, 241

6 A small ventral valve with cardinal spines. x 2

Grande Grève limestone. Percé Rock

7 Internal cast of a ventral valve, showing the course of the cardinal spines. x 3

8 Internal cast of the ventral valve with muscular scars

9 A similar view of the ventral valve

10 Enlargement of the interior palliai surface. x 5

11 A ventral valve

12 Enlargement of the exterior showing the character of the striation. x 5

13 A small ventral valve

Grande Grève limestone; divisions 1, 2. Grande Grève

Chonostrophia dawsoni Billings

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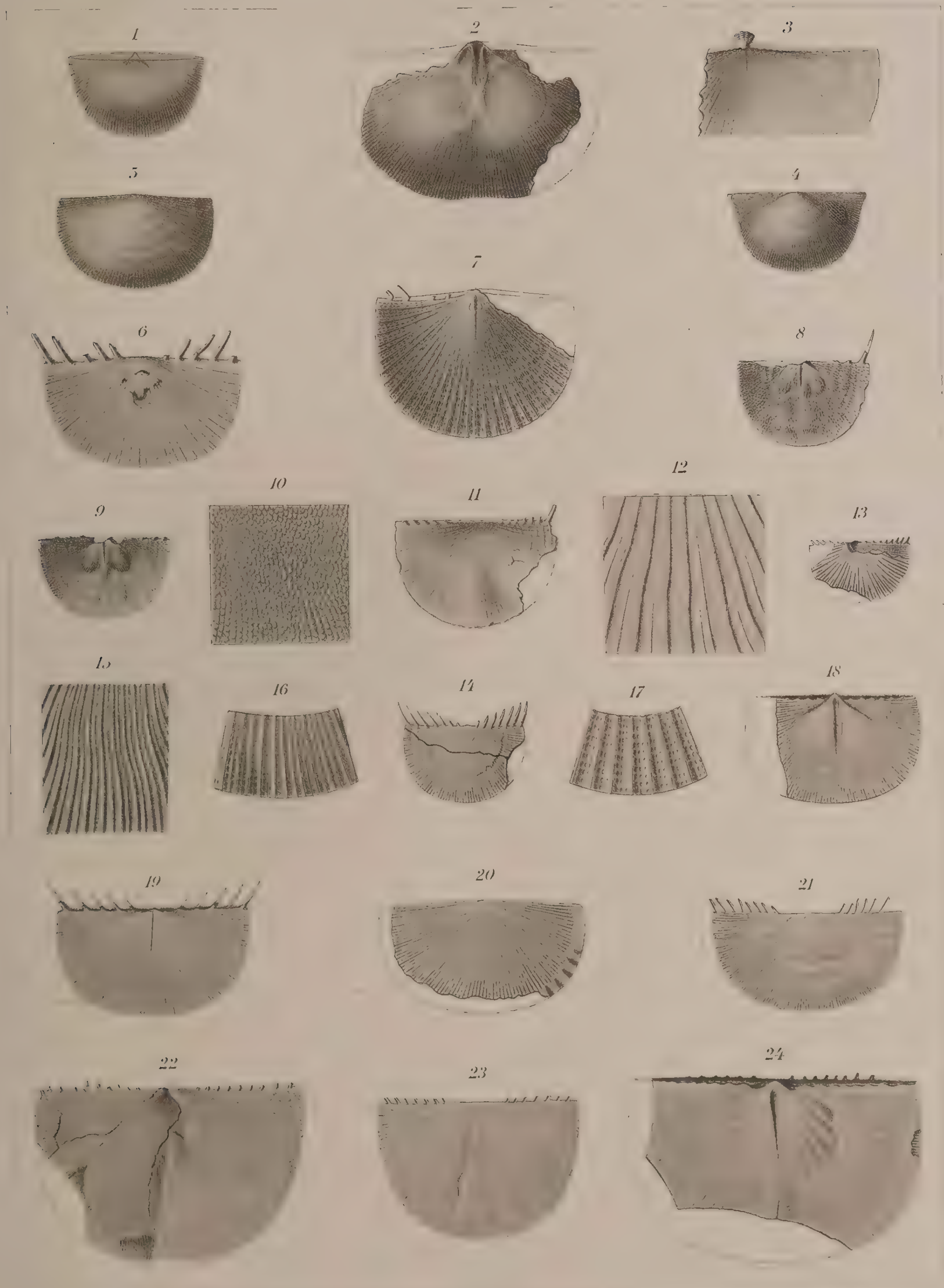
14 A small ventral valve with full array of spines

15 The external surface. x 5

BRACHIOPODS



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16, 17 More or less exfoliated parts of the surface. x 5

18 Internal cast of a ventral valve

19 Similar view with spines retained

20, 21 Ventral valves

22 Interior of a large ventral valve, part of the shell being lost

23 Exterior of a ventral valve

24 Internal cast of a large ventral valve

Gaspé sandstone. Gaspé Basin

PLATE 47

Lingula spathata Hall

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1 Fragment of large ventral (?) valve

2 Internal cast of umbonal part of valve

Grande Grève limestone. Percé Rock

Lingula rectilatera Hall

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3 Specimens showing outline, interior and exterior of the valves

5, 6 Opposite sides of a free example

Grande Grève limestone. Percé Rock

Lingula elliptica nov.

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4 A ventral (?) valve showing median septum

Grande Grève limestone; division 1. Grande Grève

Glossina acer nov.

Page 214

7, 8 Small and larger specimens

9 The surface sculpture enlarged

Grande Grève limestone; division 1. Grande Grève

Pholidops cf. **ovata** Hall

Page 212

10, 11 Exterior and interior of valves enlarged

Grande Grève limestone. Grande Grève

Crania pulchella Hall & Clarke

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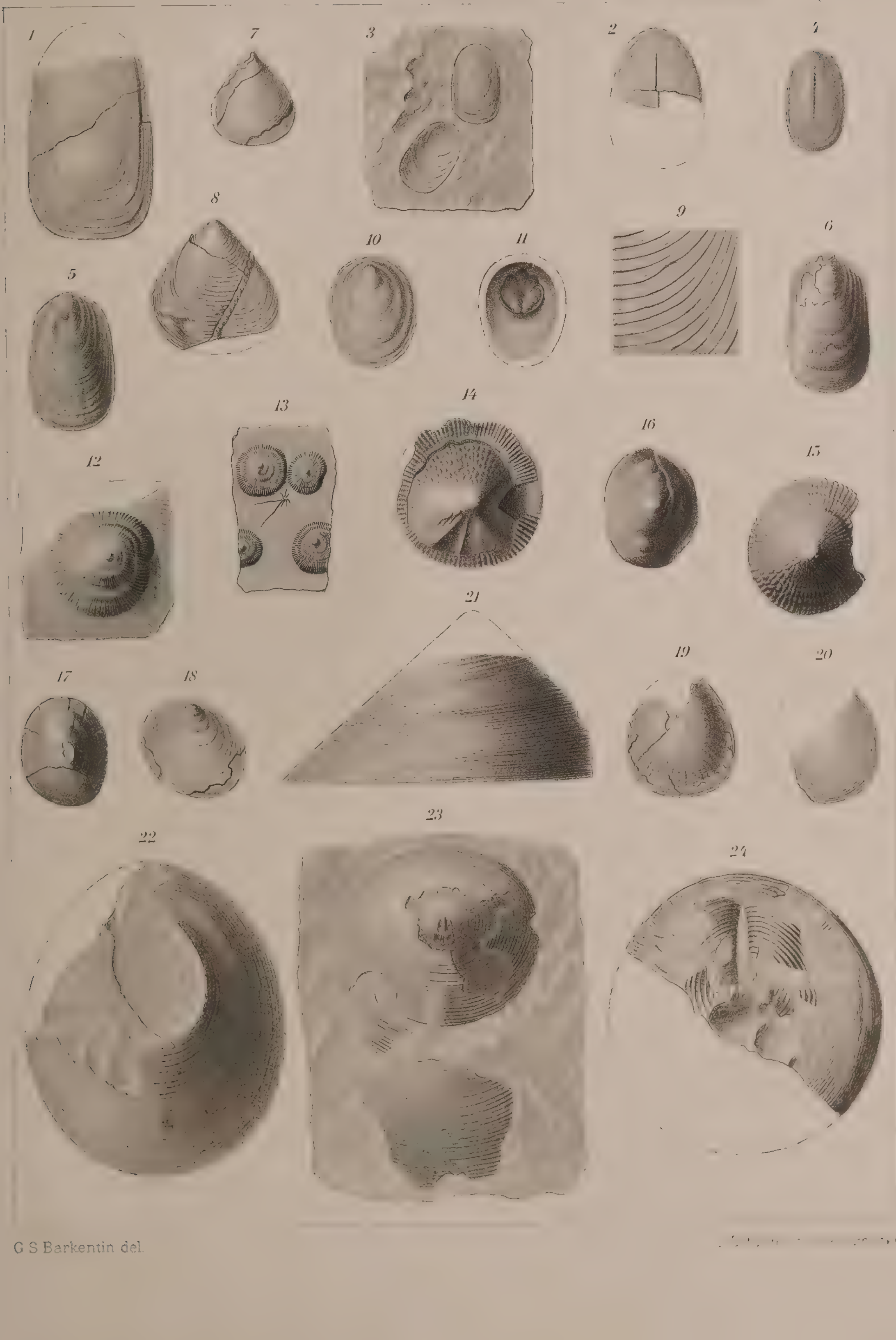
12 An attached shell showing the exterior

13 A group of small shells attached to a large pelecypod

14, 15 Somewhat exfoliated examples enlarged

Grande Grève limestone. Grande Grève

BRACHIOPODS



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Craniella (?) grandegrevensis nov.

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16 Exterior of upper valve

Grande Grève limestone. Grande Grève

Orbiculoidea bella (Billings)

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17, 18 The originals of Crania bella Billings

Cape Bon Ami beds. Cape Bon Ami

Orbiculoidea sp?

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19, 20 An unidentified species

Grande Grève limestone. Shiphead

Orbiculoidea montis nov.

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21, 22 A large upper valve

23 Compressed and broken specimen of a very large shell

24 A pedicle valve

Grande Grève limestone. 21, 22, 24 Grande Grève; 23 Percé Rock

PLATE 48

Pleurodictyum lenticulare Hall var. **laurentinum** nov.

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1 Top view of a corallum replaced by silica
Grande Grève limestone. Grande Grève

Hederella blainvillii nov.

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2 A valve of Leptostrophia blainvillii covered by a colony of this species. x $1\frac{1}{2}$
Gaspé sandstone. Portage road

Chaunograptus gracilis nov.

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3 A valve of Leptostrophia magnifica carrying a growth of this species

4, 5 Enlargement of the fronds
Grande Grève limestone; division 1. Grande Grève

Alga

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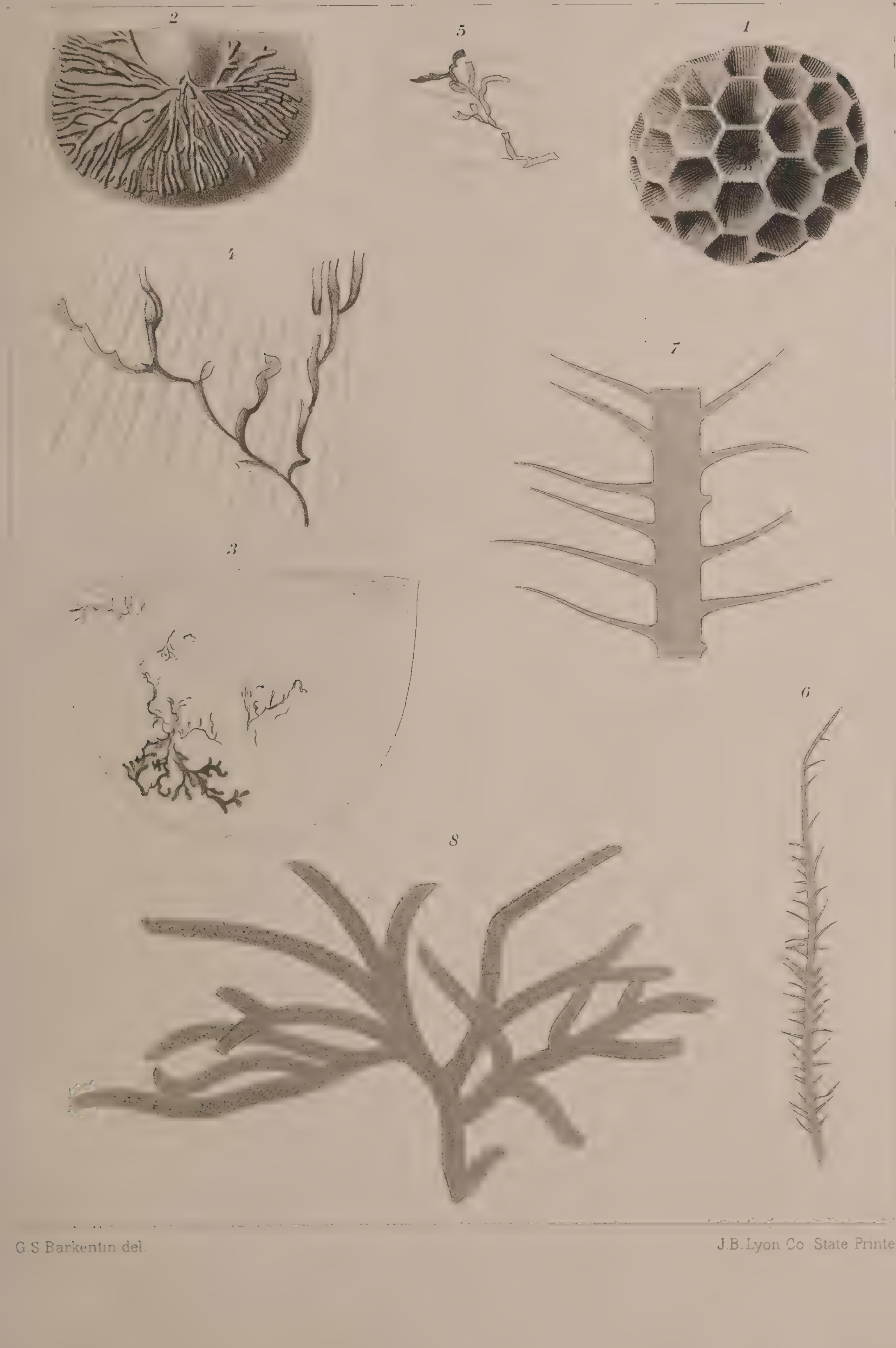
6, 7 Natural size and enlarged views of the specimen described
St Alban beds. Cape Rosier Cove

8 A fucoidal frond from the Grande Grève limestone, Grande Grève

VARIA



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